OPERATING AND SERVICE MANUAL

UNITRON FREQUENCY CONVERTER

(AVTEL CORPORATION 1969)

CR 054-3, PART NUMBER 17509

Unitron

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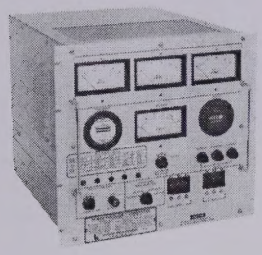
Unitron
POWER SYSTEMS

CR SERIES
50/60 Hz - 400 Hz
FREQUENCY CONVERTER
2.5 kVA to 7.0 kVA



INPUT:

Voltage Range	120/208 VRMS ±10%
Configuration	3-Phase, 4 Wire
Frequency Range	45 to 66 Hz
Protection	45 AMP Circuit breaker, over/undervoltage, loss of phase, over/ underfrequency, over current, short circuit

OUTPUT:

Power	2.5, 5.0, or 7.5 kVA (specify)
Overload	125% for 1 minute, 150% for 5 seconds (10% duty cycle)
Configuration*	3-Phase, 4 Wire
Voltage*	120/208 VRMS ±2.0% (Adjustable ±10%)
Current	Adjustable 0-150% max rated load
Response Time	A sudden 50% load change of 0.8 lagging power factor causes output voltage deviation of ≤ 13%. The terminals will recover within 0.10 second.
Frequency	400 ± 2 Hz (Adjustable ±10%)
Phase Angle	120 ± 1° balanced load; 120 ± 3° unbalanced loads up to 50%
Amplitude Modulation	1% max
Power Factor Range	0.7 lag to 0.7 lead
Distortion	1.0% typ., 1.5% max.
Protection	Overvoltage, overload, short circuit
Efficiency	75% min. at rated load

APPLICATION:

Since its beginning in 1960, Unitron has focused on the design and development of reliable solid-state power systems. The CR SERIES Frequency Converters provide 400 Hz 120/208 VRMS (Nominal) 3-phase power from a 50/60 Hz 120/208 VRMS input source. These versatile converters have been designed to meet the exacting needs of ground, mobile and shipboard support equipment as well as design, test and manufacturing laboratories and plants.

CONTROLS:

Input / Output Voltmeter • Output Ammeter for each phase • Output Frequency Meter (reed type) • Voltage / Current / Frequency Adjustment and Lock Controls • Voltmeter Switch • Standby Operate Toggle Switch • Input Circuit Breaker • Output Circuit Breaker• Elapse Time Indicator • Output Line Drop Compensation Adjusts

INDICATOR LAMPS:

Input Power On • Input Under / Overvoltage • Input Under / Overfrequency • Input Incorrect Phase Rotation • Input Loss of Phase • Input Overload • Output Overvoltage • Output Overload • Over Temperature

MECHANICAL:

Size	17.5" height, 19" width, 24" depth
Weight	2.5 kVA = 250 lbs. 5.0 kVA = 255 lbs. 7.5 kVA = 265 lbs.
Connections	Input: MS 3102A-24-22P Output: MS 3102A-24-22S
Paralleling	With identical units for increasing system power capacity

ENVIRONMENTAL:

Temperature	0°C to +50°C operating; -20°C to +71°C storage
Altitude	15,000 ft. operating; 50,000 ft. storage
Acoustical Noise	65db average at 5 ft.
Vibration	MIL-STD-810B, Method 516.1-2 Proc. I, and Meth. 514.1 Table VII
Humidity	MIL-STD-810E, Method 507.3 (95% RH max at 30°C)
RFI	MIL-STD-461A, Change Notice 6, Class V Procedure, CE03-RE02 Relaxed 20db

REV. B

**** 115 VRMS, Three Phase, 3 wire, delta optional***

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Unitron
POWER SYSTEMS

CR SERIES
50/60 Hz - 400 Hz
FREQUENCY CONVERTER
2.5 KVA to 7.0 KVA

OPERATING AND

SERVICE MANUAL

AVTEL PART NO. 17509

MODEL NO. CR 054-3 G

MANUAL NO. 21057

AVTEL CORPORATION 1969

OPERATING MANUAL

AVTEL PART NO. 17509
SERIAL NO. 001 AND SUBSEQUENT

MODEL CR 054-3-G
FREQUENCY CHANGER

OPERATING MANUAL

AVTEL PART NUMBER 17509

Serial Number 001 and Subsequent

MODEL CR 054-3-G

FREQUENCY CHANGER

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THE AVTEL CORPORATION
Covina, California

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Chassis	Drawing No. 18193
Card Cage	Drawing No. 18440
Control Board	Drawing No. 17867
Trigger Board	Drawing No. 17883
Clock Board	Drawing No. 18389
Inverter	Drawing No. 17787

SECTION I

GENERAL

1.1 GENERAL DESCRIPTION

The Avtel Corporation's 5 KVA Frequency Changer, Avtel Part No. 17509, generates a nominal 120-volt, 400-Hz, 3-phase, 4-wire, 5 KVA output when provided with a 440-volt, 3-phase, 60-Hz input. Overload protection is provided by current limiting and magnetic circuit breakers at input and output. The unit is designed to be rack-mounted in a standard 19-inch relay rack by use of side-mounted slides or base support.

1.2 SPECIFICATIONS

INPUT

Voltage:	396-484 volts, 3-phase
Current:	12 amperes
Frequency:	50-60 Hz

OUTPUT

Voltage:	Adjustable from 95 to 135 V line to line
Current:	23.5 amperes maximum
Power:	5 KVA
Frequency:	400 Hz ±.25% (Adjustable)
Distortion:	Less than 3%
Load Power Factor:	.7 leading to .7 lagging

PROTECTIVE DEVICES

Input Overload:	Magnetic circuit breaker, 15 amperes.
Output Overload:	Magnetic circuit breaker, 15 amperes, 3Ø. Electronic current sensing with current limit adjustment with overload and automatic reset.
Temperature:	Thermostat on heatsinks disables output voltage at +167 °F.

CONTROLS AND INDICATORS

Input ON-OFF:	Circuit breaker on three lines.
Output ON-OFF:	Circuit breaker, three lines.
Output Standby:	Toggle Switch.
Frequency Adj.:	Front panel screwdriver adj.
Output Voltage adj.:	Front panel knob.
Output Current adj.:	Front panel knob.
Output AC Voltmeter:	0-150 volts full scale.
Output AC Ammeters:	0-25 amps full scale.
Input Indicator:	Amber lens.
Output Indicator:	Amber lens.
Overtemp Indicator:	Red lens.
Overload Indicator:	Red lens.

CONNECTORS

INPUT:	MS3102A18-10P
	Line Phase A to Pin A.

CONNECTORS (cont.)

INPUT:	Line Phase B to Pin B.
	Line Phase C to Pin C.
	Chassis ground to Pin D.
OUTPUT:	MS3102A18-10S
	Phase A at Pin A.
	Phase B at Pin B.
	Phase c at Pin C.
	Ground at Pin D.
INPUT To Input Transformer J1:	MS3102A24-22P connections as above

COOLING

The unit is forced-air cooled by a 120-volt, 60-Hz, 1Ø, 500 cfm fan.

ENVIRONMENT

Temperature:	0 to 50°C ambient.

PHYSICAL DIMENSIONS

Width:	19"
Height:	26"
Depth:	21"
Weight:	380 lbs.
Mounting:	Rack-mounted with provisions for side-mounted slides (Grant Industrial Slides, P/N 4020B or equal).

1.3 INSTALLATION

The Avtel Power Supply, Part No. 17509, is provided with a standard 19-inch panel for rack mounting. The front panel alone will not support the weight of the power supply when installed in a rack.

The unit must be supported at its base, or if accessibility is required, by chassis mounting slides for which side mounting provisions have been made (Grant Industrial Slides P/N 4020B or equivalent).

The screw slots on the front panel are to be utilized only to prevent the unit from sliding within the rack. Be sure that the installation leaves a minimum of four inches around all sides, except the rear, for cooling air exhaust. Intake air must be ducted to the intake filter located in the rear to prevent heated exhaust air from being recirculated through the unit. This requirement is not necessary if the unit is not confined in an enclosure.

Units with option G utilize an input transformer in the base of the unit to convert the 440 3Ø input voltage to 120/208.

SECTION II

OPERATING INSTRUCTIONS

2.1 TURN-ON PROCEDURE

After having satisfied the input and output wiring requirements to the proper input and output connector pins (see Paragraph 1.2 - CONNECTORS), proceed as follows:

(a) Before applying power to equipment, set STANDBY switch and INPUT and OUTPUT circuit breakers to OFF positions. Set current limit control to desired setting.

(b) Set INPUT circuit breaker to ON.

(c) Set STANDBY switch to ON.

(d) Set OUTPUT circuit breaker to ON.

(e) Unit is now in normal operating mode. Front panel voltmeter should indicate 120 volts ±1 volt for all three output lines. (120 is factory adjustment. Adjustable by Front Panel control.)

2.2 TURN-OFF PROCEDURE

(a) Set STANDBY switch to OFF.

(b) Set OUTPUT circuit breaker to OFF.

(c) Set INPUT circuit breaker to OFF.

2.3 OVERLOAD PROTECTION

Input and output circuit breakers are provided in the event a malfunction occurs. All input lines are opened if the input current exceeds 15 amperes. The

output breaker is rated at 25 amperes with all the output lines interrupted in the event of a malfunction in the current limiting and electronic overload sensing circuits.

The overload lamp is energized if the output current exceeds 30 amperes instantaneously and disables the output voltage.

If either the INPUT or OUTPUT breakers trip, set the STANDBY switch to OFF position before resetting the breakers.

2.4 OVERHEAT PROTECTION

A thermal switch located on the inverter assembly will prevent the unit from exceeding the safe operating limits of the semiconductors. If the OVERTEMP lamp becomes energized, the unit should be turned OFF until the cause of overheating is determined.

Overheat can be caused by excessive ambient or cooling air temperature, an airflow restriction at either the intake or exhaust ports, or a defective fan.

SECTION III

THEORY OF OPERATION

3.1 GENERAL

The Avtel Frequency Changer consists of two main components. A) a rectifier and filter section that generates a DC voltage of adjustable magnitude (the so called "DC Link") and B) the inverter section which produces the desired AC output voltage of controlled frequency and waveform. The AC output from the inverter is roughly proportional to the DC supply level, and therefore the output voltage and/or current level are readily controlled by acting upon the input rectifier section which is of the phase controlled type.

Where a frequency changer is supplied with options "A", "B" or "C", which require operation from a battery DC source, the input rectifier is used as a battery charger while the output voltage and/or current is controlled by phase shifting two additive sine waves.

3.1.1 RECTIFIER AND FILTER SECTION

A full-wave phase controlled rectifier using silicon thyristors and diodes (single phase only) converts the input AC of specified frequency, phase, and voltage range (see "Specifications" for a detailed listing of applicable parameters for this unit) to a pulsating direct current which is subsequently smoothed by an inductor-capacitor filter and thus becomes the power source for the inverter.

The DC output level is increased or decreased by advancing or

retarding respectively, the square wave gate signal applied to each thyristor (SCR) with respect to its anode to cathode voltage.

To insure a stable triggering signal and uniform input line current, (in the case of three phase input units), a phase lock loop provides a line reference signal which ignores rapid fluctuations in the input power lines.

This line reference is a square wave (three square waves 120 degrees displaced from each other in three phase input units) which if used to gate the SCR's would cause full conduction and therefore maximum output voltage. The actual gating waveform is obtained from the reference by an error voltage controlled time delay, such that if the DC output level is above the correct value, the conduction angle is reduced as required to maintain the AC output voltage/current at the present level, in spite of line and/or load changes.

3.1.2 INVERTER SECTION

The output sine wave is sinthesized by vector addition of several modified square waves, or "zero third harmonic" waveforms. Avtel Frequency Changers use three-phase inverters of the "up and down" kind as building blocks. In three-phase output units, two such identical blocks are connected to two delta primary output transformers. One such transformer carries single secondary windings, one per output phase, and the other transformer has dual secondary windings. By addition of these secondary voltages, twelve step quasi-sine waves are obtained, which are then filtered as required to meet the distortion specifications.

3.2 DETAILED CIRCUIT DESCRIPTION

3.2.1 INTERNAL POWER SUPPLIES

After passing through RF Filter (RFF101) the line voltage is applied to the main power circuit breaker. When the main input breaker is closed, power is supplied to the primary of transformer T101 which steps down the voltage to 115 Volts for operation of the blower, and to 50V C. T. which is rectified by CR19 and CR20 (located in the card cage area) and filtered by capacitor C113 (located on the main chassis) to furnish the raw DC for the operational supply. A "test"-"operate" switch, S101, allows the auxiliary power transformer T101 to be energized without applying power to the main rectifiers for the purpose of trouble-shooting the control circuitry without risking a catastrophic failure of either the main power supply or the output inverter. This switch is located adjacent to the card cage area and is accessible after removing the card cage access plate. This switch should normally be left in a "down" or "operate" position.

Approximately 28 Volts (at nominal input line) is applied to a series type regulator consisting of transistor Q1 (on the card cage) and the control circuitry (which is located on the control board, drawing number 17867) consisting of differential stage Q22 and Q23, amplifier Q24, and emitter-follower Q25. The reference voltage for this regulator is supplied by zener diode CR35 which has a nominal voltage of 6.2 Volts. A divider across the plus (+)20 Volt buss applies a portion of that voltage (which is variable by means

of potentiometer R93, the 20 Volt adjust potentiometer) to the base of Q22. If the plus (+)20 Volt buss is at higher than normal voltage this will cause an increase in the current of Q22 and a decrease in the current of Q23, and therefore, more current will be available to drive Q24 which will in turn reduce the drive to Q25, and to Q1, which is the pass transistor. This in turn will decrease the output voltage and bring it into correspondence with the set level.

The plus (+)20 Volt buss feeds the 5 Volt regulator consisting of dropping resistor R37 and zener diode CR21, and emitter-follower Q2. This plus (+)5 Volt level is used to power the digital integrated circuits.

The low voltage AC from the secondary of transformer T101 is also applied to the control board, drawing 17867, at pins 1 and B where it is rectified by CR1 and CR2 and filtered by capacitor C1 to provide approximately 26 Volts negative (-) with respect to common. Transistor Q26 acts as a constant current source for zener diodes CR4, CR8, and CR9, and thus provides a minus (-)15 Volt reference voltage which is also used as the negative supply for the linear integrated circuits. The positive supply for the linear integrated circuits (plus (+)15 Volts) is obtained from the plus (+)20 Volt buss by means of dropping resistor R7, and zener diode CR5.

3.2.2 LINE SYNCHRONIZATION PHASE LOCK LOOP

A sample of the input line is obtained from either a separate synch. transformer or directly from one of the secondary terminals of transformer

T101 and applied to pin A of control board 17867 where after being phase shifted about 90 degrees by resistors R6, R27, R21, and capacitor C5, it is amplified by the integrated circuit operational amplifier, IC1. The output at pin 6 of IC1 is a square wave which is nearly 90 degrees delayed with respect to the input synch. signal. Transistor Q1 inverts the signal and the two complementary square waves are one set of inputs to a phase detector consisting of transistors Q2, Q4 and Q3. The signal at pins 4 and H of the control board is the reference square wave generated by the loop. This is the second set of inputs to the phase detector. The output at the collector of Q3 is a switched waveform, varying between approximately 0 Volts and 5 Volts and with an average value depending upon the phase shift between the two sets of inputs.

When both inputs are at 90 degrees relative phase displacement the average level is about 2.5 Volts positive (+) which is then filtered by the active filter consisting of transistors Q5 and Q27, and level shifted by a divider network consisting of R32, potentiometer R33 and R34. Potentiometer R33 allows small changes of the relative phase between the input line synch. and the generated line reference square wave. The voltage at the arm of R33 is then applied to an operational amplifier connected as an integrator, with C6 being the integrating capacitor and R35 the input resistor.

The output from IC2 is level shifted by zener diode CR46 and is then applied to the base of Q1 located on the trigger board, drawing 17883. Q1 provides an adjustable current source for the relaxation oscillator consisting

of unijunction Q2 and C1. In three-phase units Q2 is adjusted to operate at 6 times the line frequency, while in single phase units it is set to operate at twice the line frequency. The output from Q2 is then amplified by Q3 and applied to Q4 which is the clock driver for the integrated circuit flip-flops, IC1A, IC2A and IC3A. These are connected as a Modulo 6 Johnson counter in the case of three-phase units, while in single phase units only IC1A is used as a "divide by two" circuit. The reference for the phase lock loop is obtained from IC1A in single phase units and IC2A in the case of three-phase units and is then applied as the second set of inputs to the phase detector, thus closing the loop.

A tachometer circuit composed of Q19, Q20, and associated components generates a DC voltage proportional to the input line frequency which is then filtered by Q28 in an active filter configuration. This DC level is applied to the integrating amplifier IC2 which is connected as a unity-gain amplifier by the action of Q6. This charges up capacitor C6 to approximately the proper level so that when Q6 is opened, the phase lock is able to acquire lock rapidly. The switching of Q6 and Q7 is controlled by the charging of C22 through R40.

3.2.3 ERROR AMPLIFIER

A sample of the AC output voltage is full-wave rectified and applied to the control board, schematic 17867, and after filtering by C24, it is applied through a summing network to the base of Q8. The other input to the base of Q8 comes from the arm of the voltage control potentiometer, located normally on the front panel. The potentiometer is supplied with a stable negative reference

voltage obtained from the minus (-)15 Volt buss. R42 is the AC voltage range adjust potentiometer and is used to make minor changes in the output voltage range. The base of Q9 is normally returned to common, and if the output voltage is greater than the desired level collector, a positive voltage will be applied to the base of Q8 which will increase the current of Q8 and reduce the voltage applied to the base of the emitter-follower Q18, which is the error amplifier output stage. The normal range of the error voltage is from plus (+)10 Volts corresponding to zero conduction of the B-plus (+) supply SCR's, to plus (+)15 Volts, for full conduction.

A similar differential pair, Q16 and Q17, compares a sample of the output current applied at pin P on the board with the current limit reference set by the arm of the current limit control potentiometer or by a fixed divider if no control is provided on the front panel. Consequently, if the output current increases above the set limit, the action is similar and the voltage at the collector of Q16 goes down and so does the output from the Q18 error amplifier, reducing the conduction angle.

Diodes CR15 and CR29 allow a very sharp changeover from the constant voltage mode to the constant current mode. Diode CR16, which is also a part of the "OR" circuit, allows the output to be controlled by transistor Q10 and the slow start circuit composed of capacitor C8 and resistors R53 and R52. When the unit is initially turned on, capacitor C8 is discharged, and until the voltage across it reaches approximately a plus (+)15 Volt level, full conduction is not allowed. As capacitor C8 continues its charge, it eventually reaches essentially

plus (+)20 Volts, Transistor Q10 allows the output to be immediately reduced in case of either an overload or an over-temperature indication, or if the standby switch is returned from the "on" position to the "standby" position. This action is accomplished by applying the output from the different protection circuits through a diode "OR" gate composed of CR32, CR33 and CR24 to the base of Q10, thus turning Q10 on and discharging the slow start capacitor C8 and also reducing the voltage applied to the base of Q18 to a point low enough to cause zero conduction of the "B" plus SCR's. After removal of the alarm condition, a new slow-start cycle occurs as C8 charges up towards plus (+)20 Volts.

The overload circuit is composed of differential pair Q11-Q12 and emitter-follower Q13. An instantaneous over-current condition, such as the sudden application of a cold incandescent load, causes CR17 to conduct and produces a voltage at the arm of R56 which if greater than the voltage established by zener diode CR19 will cause Q11 to conduct and Q12 to turn off, thus turning on Q13, which will then fire CR21. When CR21 fires, it discharges capacitors C10 and C30, thus removing the drive to Q14 which then allows R67 to turn Q15 on, which causes the overload indicator lamp to be energized through CR24, Q10 is turned on, thus discharging C8 and reducing the conduction angle to zero, and starting a new slow-start cycle as soon as the overload condition is removed. However, an additional delay is involved since C10 and C30 have to charge up through R65. This is the delay which, when the unit is initially turned on, causes the overload lamp to light, although no over-current condition exists at that time. This

provides the necessary delay for the logic circuitry and the control circuitry to get itself organized, and for the phase-lock loop to acquire lock.

The over-temperature indicator acts through Q21, the thermostat being normally closed. If an over-temperature condition exists, Q21 will be turned on by R89, the over-temperature indicator lamp will light up, and CR32 will turn Q10 on, shutting down the AC output. When the over-temperature condition disappears, a re-cycle of the slow-start circuit will occur, causing the output voltage to increase gradually.

In units which operate from a 440 Volt input line, an additional circuit is incorporated causing the thermostat line to be opened when one of the two series connected inverter rings "locks-up" to prevent any damage to the components by removing the B-plus supply.

The standby switch is connected between pin T of the control board and common. When the switch is in the "standby" position (open) R91 through CR33 turns on transistor Q10 holding the unit in a zero output condition. When the standby switch is turned to the output "on" position, pin T is shorted to the common, thus initiating a standard slow-start cycle.

To complete the description of the control board, integrated circuit operational amplifier IC3 is only used in A, B or C option frequency changers in which case it boosts the output from the battery current metering shunt up to the level provided by the output current transformer-rectifier sub-assembly.

3.2.4 VOLTAGE CONTROL TIME DELAY CIRCUITRY

The reference square waves generated by IC1A, IC2A and IC3A on the trigger board, schematic 17883, are differentiated by C15, R11 and R14, and positive going transitions from both the Q and the Q outputs are applied to the base of Q5 which turns Q5 on and saturates Q6, thus discharging capacitor C17 in the collector circuit of Q6. The charging current for capacitor C17 is provided by constant current source transistor Q7 with the control voltage provided by a tachometer signal obtained from the one short circuit, Q19 and Q20 on the control board.. This voltage is directly proportional to the input line frequency, therefore the charging current for capacitors C17 is proportional to frequency and the amplitude of the sawtooth generated on C17 remains constant as the input line frequency changes.

This sawtooth generated at the collector of Q6 is applied to the base of Q8 which is part of the differential comparator stage where Q9 is the other half. The input to Q9 is the output from the error amplifier previously described. Since the voltage on the base of Q8 is negative going and starts at approximately a plus (+)15 level and goes down to plus (+)10 Volts, when the error voltage coincides with the instantaneous value of the sawtooth, conduction is transferred from Q9 over to Q8, the collector of Q8 thus becomes positive and through R25 and zener diode CR4 turns on transistor Q10.

Integrated circuit flip-flop IC1B is supplied with both set and reset inputs which are, in fact, the line reference square wave, and since this is a gated flip-flop, no action takes place until the clock pulse is produced. So at

the time of coincidence between the sawtooth and the error voltage, IC1B is switched to the "on" or "off" state, depending on the state of its set and reset inputs. This causes its output at Q15 to go high, for instance, which then allows R33 through Q11 to provide drive to output driver Q13 which is connected to one-half of the "B" plus SCR trigger transformer and turns on the appropriate SCR. Components associated with Q10, such as CR3, C19 and CR5, allow operation under conditions of either zero conduction or full conduction when Q10 would be either turned on all the time, or turned off all the time.

All three time delay circuits are identical and, of course, only one channel is used in the single phase application. The appropriate phase-lock loop outputs are connected by means of jumpers C&E or F&D. Transistor Q43 on the trigger board acts as a gating transistor for the "B" plus 20 Volt supply to the "B" plus trigger transformers, and it is controlled by the action of transistor Q10 on the control board when an alarm condition occurs, or the standby switch is turned to the "standby" position, removing the base drive to Q43 and the supply voltage to the SCR trigger transformers.

3.2.5 INVERTER DRIVE CIRCUITS

The inverter is a impulse computated up and down type (see drawing number 17787). A typical leg such as CR1 and CR2, is triggered by a square wave of opposite polarity for respective SCR's such that when CR1 is turned on it causes a negative voltage to appear on the anode of CR2, and turns CR2 off.

The voltage appearing at the center tap of inductor L1 is a square wave at the output frequency and has a value corresponding to the supply voltage on CR1 on one half cycle and has a voltage of zero on the other half-cycle. The similar waveform appearing at the center tap of L2 is phase displaced with respect to the previous one by 120 degrees. The voltage between points E12 and E15 is therefore modified square wave with a 120 degree period where the voltage is at the plus (+) supply level, then a 60 degree period with zero voltage, next a 120 degree period where the voltage is of opposite polarity and equal in magnitude to the total supply voltage and followed by a final 60 degree period of zero voltage. This type of waveform has triplet no harmonics and it is applied to one of the legs of the three-phase transformers, the second leg being supplied by a similar waveform that is 120 degrees displaced and appears between E15 and E18, and the third leg receiving the voltage between points E18 and E12.

The second half of the inverter is identical except that the waveforms are phase displaced by 30 degrees with respect to those supplied by the first inverter. As a consequence, it is necessary to provide typically 6 square waves of 30 degrees relative phase displacement. These are generated in a shift register or a ring counter. On some units integrated circuits are used (see drawing 17874) and the equivalent arrangement using discrete components is shown on drawing 18136. In either case a clock pulse of twelve times the output frequency must be provided. This is generated in the clock section shown on

trigger board 17883 (see, for instance, UJT Q28 and transistors Q29 and Q30). In most cases, Q15, Q16 and Q17 are not used since they are only required when a second slave clock is needed to implement phase shift regulation of the output.

Q28 is a standard UJT relaxation oscillator with frequency determined by the frequency adjustment potentiometer normally located on the front panel and/or R115 (frequency range adjust) and R47 together with capacitor C9. The pulse appearing at base 1 of Q28 is applied to the base of Q29 and the amplified single is in turn applied to the base of Q30, causing its collector to vary between essentially ground and plus (+)5 Volt. This is the arrangement normally used with integrated circuit shift registers. Where a discrete clock is used, the appropriate clock signal is negative going between levels of approximately plus (+)10 Volts and zero.

When a crystal controlled frequency is required, transistors Q31 and Q32 with crystal Y1 form a basic crystal oscillator which normally works at 4 times the trigger frequency or 48 times the output frequency so that for a 400 hertz output unit the crystal operates at 19.2 kilohertz. Unijunction Q28 operates at 12 times the output frequency, and it synchronized by the clock signal where both fixed frequency and crystal frequency operation is required. When only fixed frequency operation is desired, and an integrated circuit clock is used, transistors Q28, Q29 and Q30 may be deleted. Integrated circuit IC5, dual flip-flop, is used to provide the additional frequency division required at low output frequencies, such as 50 or 60 hertz.

When the integrated circuit shift register is used (see schematic 17874) only transistors Q15 through Q26 and Q39 through Q50, and IC4, 5, and 6 are normally used. The other half of the board, which is identical, is only used for twelve-phase or phase shift regulation units, such as options A, B or C. Outputs from the dual flip-flops, of type SN7473N, appear at pins 12 and 13 and pins 8 and 9, and when a particular output goes to its positive level such as pin 13 in IC4, it allows resistor R17 to provide base drive to driver transistor Q39 which applies plus (+)20 Volts to driver transformer T13 through limiting resistor R13, and thus provides the gate triggering to SCR CR1, which as it turns on provides the necessary reverse voltage for CR2 to turn off by action of the commutating choke L1 and the commutating capacitor C3. Transformers T1, T2 and T3, rectifiers CR3, CR4, CR7, CR8, CR11 and CR12, allow a return of the trapped energy to the supply line as well as serving as pump back diodes, under reactive load conditions.

Phase Lock Board (for ext. sync option)

The output frequency is sampled by reconstructing a sine wave replica at R101-C101 junction. The sync input, via T101, gates Q101, causing F.E.T. Q102 to sample the output replica. Q103 and Q104 establish a DC voltage proportional to the output frequency which is compared to a fixed reference in differential amplifier Q105 - Q106. The resulting error voltage changes the frequency the UJT relaxation oscillator Q108. The output of Q109 becomes the clock pulse for the inverter clock board, changing the output frequency until no error voltage is produced in the loop.

Q110 resets free running oscillator Q111 with each sync input. In the event of a input sync loss, C110 is allowed to charge up, turning Q112 on, thus energizing K101 via Q113. The relay pole, N.O., and N.C. contacts (1 amp rating) are brought out to J103 for sync loss alarm purposes (see card cage schematic). Because of the high impedances around C105, it will hold its charge for a relatively long time in the event of a sync loss. Thus the output frequency does not rapidly drift, but tends to stay close to the frequency before sync loss.

DESCRIPTION OF TEST POINTS

TEST POINT NUMBER	
1.	Card cage common.
2.	Input line synch signal.
3.	Input ØA reference (locked to synch).
4.	ØA B+ SCR driver (conduction angle).
5.	0° inverter driver.
6.	Unfiltered B+.
7.	Filtered B+.
8.	B-
9.	Unfiltered quasi-step sinewave ØA.
10.	
11.	Voltmeter
12.	Selector Wiper

NOTE:

For test points 1 through 5, reference scope to TPI.

For B+, reference to B- (TP8).

For unfiltered ØA, connect scope across TP9&10.

For filtered output, connect scope across TP11&12, switch front panel voltmeter switch for all output phases.

CODE - VENDOR REFERENCE

Source Code	Vendor Name	Address
1	The Avtel Corporation	1130 E. Cypress, Covina, California
2	Allen-Bradley Resistor Co.	Milwaukee 4, Wisconsin
3	Ohmite Resistor Co.	3601 Howard St., Skokie, Illinois
4	Electra Capacitor Co.	800 N. 21st St., Independence, Kansas
5	Bourns Laboratories, Inc.	6135 Magnolia Ave., Riverside, Calif.
6	Victory Engineering Corp. (VECO)	Springfield Ave., Springfield, N.J.
7	Spicer Electric	3088 E. Villa St., Pasadena, Calif.
8	Dale Electronics	P.O. Box 609, Columbus, Nebraska
9	International Resistance Co.	1136 N. La Brea Ave., Hollywood, Calif.
10	Marco Oak Mfg. Co.	Anaheim, California
11	Rotron Mfg. Co.	Woodstock, New York
20	Kemet Dept.	P.O. Box 6087, Cleveland, Ohio
21	Mallory Capacitor Co.	P.O. Box 372, Indianapolis, Indiana
22	Cornell Dubilier	South Plainfield, N.J.
23	Sprague Electric Co.	12870 Panama St., L.A. 66, Calif.
24	Arco-Emenco	Community Dr., Great Neck, N.Y.
25	Dilectron	2669 S. Myrtle Ave., Monrovia, Calif.
26	Electro Cube, Inc.	805 Fairview Ave., S. Pasadena, Calif.
27	Electron Products Co.	1960 Walker Ave., Monrovia, Calif.
40	Continental Device Corp.	12515 Chadron Ave., Hawthorne, Calif.

Source Code	Vendor Name	Address
41	Hughes Co., Inc.	12515 Chadron Ave., Hawthorne, Calif.
42	Pacific Semiconductor, Inc.	8271 Melrose Ave., Los Angeles 46, Calif.
43	Universal Rectifier Co.	2055 Pontius Ave., Los Angeles 25, Calif.
44	International Rectifier Co.	233 Kansas St., El Segundo, Calif.
45	Motorola, Inc.	5005 E. McDowell Rd., Phoenix 8, Ariz.
46	General Electric Co.	3325 Wilshire Blvd., L.A. 5, Calif.
47	Fairchild Semiconductor Co.	P.O. Box 670, Mountain View, Calif.
48	Texas Instruments Co.	P.O. Box 5012, Dallas 22, Texas
49	Sylvania Electric Co.	6505 E. Gayhart, L.A. 54, Calif.
50	Delco Radio Div.	Kokomo, Indiana
51	Philco Corporation	Lansdale, Pennsylvania
66	Fenwal, Inc.	Ashland, Massachusetts
67	Winchester Connector Co.	P.O. Box 548, Norwalk, Connecticut
68	Viking	21343 Roscoe Blvd., Canoga Park, Calif.
69	Minneapolis Honeywell	11 W. Sprint St., Freeport, Illinois
70	Electric Switch Corp.	2320 S. Tibbs Ave., Indianpolis 41, Ind.
72	Eldema	1805 Belcroft Ave., El Monte, Calif.
73	Ratheon Mfg. Co.	411 Providence Turnpike, Westwood, Mass.
74	Bendix	P.O. Box 93, So. Hackensak, N.J.
76	Heinemann Electric Co.	Trenton 2, N.J.
77	Chicago Telephone Co.	Elkart, Indiana
78	Grisby Co.	Arlington Heights, Illinois

Source Code	Vendor Name	Address
79	Airpax	Cambridge, Maryland
80	Globe	1729 W. 134th St., Gardena, Calif.
81	Dow Radio, Inc.	1759 E. Colorado Blvd., Pasadena, Calif.
82	RCA	6801 E. Washington Blvd., L. A., Calif.
83	Semtech Corp.	652 Michell Rd., Newbury Park, Calif.
84	Weston Instruments, Inc.	614 Frelinghuysen Ave., Newark, N. J.
85	Dickson Electronics Corp.	P. O. Box 1387, Scottsdale, Arizona
86	Arrow-Hart	120 S. Anderson St., Los Angeles, Calif.
87	Quality Electric	3700 S. Broadway, Los Angeles 7, Calif.
88	Cannon Electric Co.	3208 Humboldt St., Los Angeles, Calif.
89	Drake Mfg. Co.	4626 N. Olcott Ave., Harwood Hgts., Ill.
90	Littlefuse	800 E. Northwest Hwy., Des Plaines, Ill.
91	Westinghouse	600 St. Paul St., Los Angeles, Calif.
92	Teledyne	3155 W. El Segundo Blvd., Hawthorne, Calif.
93	Gudeman Co.	340 W. Huron St., Chicago, Ill.
94	Sangamo	Pickens, South Carolina
95	Centralab	5757 North Green Bay Avenue, Milwaukee, Wisconson
96	Research Products	1015 East Washington Ave., Madison, Wisconsin
97	Amelco	P. O. Box 1030, Mountain View, Calif.
98	Beede Electrical Instrument	Penacook, New Hampshire

Source Code	Vendor Name	Address
99	Cutler-Hammer, Inc.	4201 North 275th St., Milwaukee, Wis.
100	TRW	112 West 1st St., Ogallala, Neb., 69153
101	US Semcor	3540 West Osborn Rd., Phoenix, Ariz.
102	Filtors, Inc.	65 Daly Rd., E. Northport, N. Y. 11731

TRIGGER BOARD ASSEMBLY

P/N 17912-3

CIRCUIT REFERENCE	DESCRIPTION	MFG. CODE	AVTEL P/N	TQ	SP
Q1,6,8,9,19,21, 22,34,36,37	TRANSISTOR 2N3702	48	014-1058	10	
Q10,23,38	TRANSISTOR 2N3904	45	014-1060	3	
Q2,28	TRANSISTOR 2N2646	46	014-1054	2	
Q13,14,26,27,41, 42	TRANSISTOR 2N697	48	014-1045	6	
Q3-5,7,11,12,18, 20,24,25,30,33,35, 39,40	TRANSISTOR 2N731	48	014-1001	15	
CR1-3,5,7-9,11-14, 16-24	DIODE 1N914	48	013-1127	20	
CR4,10,15	DIODE 1N751A	40	013-1116	3	
C1,17,25,33	CAPACITOR .1uf	26	033-1001	4	
C2,15,16,19,20,21, 23,41,43,45,24,27, 28,29,31,32,35,36,37	CAPACITOR .001uf	23	030-1001	19	
C18	CAPACITOR 2.2uf, 20V	23	037-024	1	
C3,4,11	CAPACITOR 8.2uf, 20V	20	037-1004	3	
C9,	CAPACITOR .02uf, 200V	26	033-7203	1	
C22,30,38,40,42,44	CAPACITOR .01uf, 200V	25	030-1010	6	
Y1	CRYSTAL	92	017-1007	1	
IC1-3	INTEGRATED CIRCUIT SN7476N	48	015-1003	3	
C26,34,46	CAPACITOR .1uf, 50V	23	030-145	3	
Q43	TRANSISTOR 40250	82	014-1057	1	
CR6	DIODE SCE-1	83	013-1079	1	
C47-52	CAPACITOR 360pf	24	034-4361	6	

TRIGGER BOARD ASSEMBLY

P/N 17912-3

CIRCUIT REFERENCE	DESCRIPTION	MFG. CODE	AVTEL P/N	TQ	SP
R1,4,9	RESISTOR 2K,¼W,5%,C.C	2	041-560	3	
R3,8,10,11,12,17,25, 62,63,68,76,87,88, 93,101,53,54	RESISTOR 1K,¼W,5%,C.C	2	041-495	17	
R5,27,29-32,79-83, 104-108	RESISTOR 3K, ¼W,5%,C.C	2	041-550	16	
R7, 49	RESISTOR 100ohm,¼W,5%,C.C	2	041-419	2	
R6,13,15,16,20,21, 26,64-67,28,78,71, 72,77,89-92,96,97, 102,103,114	RESISTOR 10K,¼W,5%,C.C	2	041-408	25	
R118	RESISTOR 2K,½W,5%,C.C.	2	041-010	1	
R50	RESISTOR - BUSSWIRE	2	041-1009	3	
R22,73,98	RESISTOR 100K,¼W,5%,C.C	2	041-1009	3	
R24,75,100	RESISTOR 5.1K,¼W,5%,C.C	2	041-561	3	
R33-35,84-86,109-111	RESISTOR 510ohm,¼W,5%,C.C	2	041-504	9	
R112,113	RESISTOR 10ohm,¼W,5%,C.C	2	041-496	2	
R56,60	RESISTOR 47K,¼W,5%,C.C	2	041-411	2	
R119-124	RESISTOR 200ohm,¼W,5%,C.C	2	041-740	6	
R23,74,99	RESISTOR 30K,¼W,5%,C.C	2	041-1007	3	
R2	RESISTOR T & C	4		1	
R48	RESISTOR 330ohm,¼W,5%,C.C	2	041-427	1	
R18,69,94	RESISTOR 75K,1/8W,1%,MF,5C	4	045-7502	3	
R47	RESISTOR T & C	4		1	
R14,115	POTENTIOMETER 1K	5	044-0309	2	
R19,70,95	POTENTIOMETER 10K	5	044-1055	3	

TABLE OF REPLACEABLE PARTS
CONTROL BOARD ASSEMBLY - STANDARD

P/L 17921-3

CIRCUIT REFERENCE	DESCRIPTION	MFG. CODE	AVTEL P/N	TQ	SP
C11,13,18,21,25,42	CAPACITOR .01uf	25	030-1010	6	
C26,37	CAPACITOR T & C			2	
C15,19	CAPACITOR .005uf	25	030-1002	2	
C16,20	CAPACITOR 200pf	24	034-286	2	
C27,38	CAPACITOR T & C			2	
C43,44	CAPACITOR .1uf, 50V	23	030-145	2	
C41	CAPACITOR .1uf, (Mylar)	26	033-1001	1	
Q1-4,10-15,19-24	TRANSISTOR 2N731	48	014-1001	16	
Q6,7	TRANSISTOR 2N4302	97	014-1084	2	
Q5,8,9,16,17,18,28	TRANSISTOR 2N3391	46	014-1065	7	
Q25,26	TRANSISTOR 40250	82	014-1057	2	
Q27	TRANSISTOR 2N3702	48	014-1058	1	
IC1-2	INTEGRATED CIRCUIT U5B-709C	47	015-1005	2	

TABLE OF REPLACEABLE PARTS
CONTROL BOARD ASSEMBLY - STANDARD

P/L 17921-3

CIRCUIT REFERENCE	DESCRIPTION	MFG. CODE	AVTEL P/N	TQ	SP
CR1,2	DIODE 10D2	44	013-1008	2	
CR7,11,12,15,16,18, 24-26,29-33,41,42, 44,45	DIODE 1N914	48	013-1127	18	
CR28,29	DIODE T & C			2	
CR40	DIODE 1N964B	45	013-1096	1	
CR5	DIODE 1N965B	45	013-1097	1	
CR3,4,6,8,9,10	DIODE 1N751A	40	013-1116	6	
CR17,27	DIODE 1N754A	40	013-1094	2	
CR19,23,35	DIODE 1N753A	100	013-1053	3	
CR34	DIODE 1N755	40	013-1029	1	
CR47	DIODE 1N758A	40	013-1119	1	
CR20	DIODE 1N962B	40	013-1084	1	
CR21	DIODE 2N1595	45	014-1066	1	
CR46	DIODE 1N968B	40	013-1100	1	
CR22,43	DIODE SCE-1	83	013-1079	2	
C1	CAPACITOR 75uf, 50V	22	031-283	1	
C2,9,29,36,45,23,28	CAPACITOR 8.2uf, 20V	20	037-1004	7	
C22	CAPACITOR 6.8uf, 35V	23	037-071	1	
C24	CAPACITOR 2.2uf, 20V	23	037-024	1	
C3,4,5,14,39,40	CAPACITOR .5uf	26	033-1002	6	
C6	CAPACITOR 15uf, 20V	20	037-1005	1	
C7,17	CAPACITOR .001uf	23	030-1001	2	
C12	CAPACITOR 10uf, 20V	101	037-080	1	
C8	CAPACITOR 100uf, 30V	23	037-1035	1	
C10,30	CAPACITOR 250uf, 12V	23	031-1001	2	

TABLE OF REPLACEABLE PARTS
CONTROL BOARD ASSEMBLY - STANDARD

P/L 17921-3

CIRCUIT REFERENCE	DESCRIPTION	MFG. CODE	AVTEL P/N	TQ	SP
R54,85,87,32	RESISTOR 3K,¼W,5%,C.C.	2	041-550	4	
R39,63,53,71	RESISTOR 100ohm,¼W,5%,C.C	2	041-419	4	
R49,79	RESISTOR 22K,¼W,5%,C.C.	2	041-406	2	
R52,81	RESISTOR 47K,¼W,5%,C.C.	2	041-411	2	
R58,60,95,97	RESISTOR 6.2K,¼W,5%,C.C.	2	041-538	4	
R61,98	RESISTOR 4.7K,¼W,5%,C.C.	2	041-412	2	
R98,91	RESISTOR 3.3K,¼W,5%,C.C.	2	041-407	2	
R94	RESISTOR 390ohm,¼W,5%,C.C.	2	041-417	1	
R69	RESISTOR 26.1K,1/8W,1%,MF	4	045-2612	1	
R114	RESISTOR T & C,¼W,5%,C.C.			1	
R119	RESISTOR T & C,¼W,5%,C.C.			1	
R121	RESISTOR T & C,¼W,5%,C.C.			1	
R1,2	RESISTOR 4.7ohm,½W,5%,C.C	2	041-654	2	
R11,12,16,18	RESISTOR 4.7K,½W,5%,C.C.	2	041-013	4	
R125	RESISTOR 680ohm,½W,5%,C.C	2	041-343	1	
R3	RESISTOR 120ohm,½W,5%,C.C.	2	041-553	1	
R41	RESISTOR 1K,½W,5%,C.C.	2	041-245	1	
R64	RESISTOR 1ohm,½W,5%,C.C.	2	041-1033	1	
R68,90	RESISTOR 220ohm,½W,5%,C.C.	2	041-004	2	
R100	RESISTOR 51ohm,½W,5%,C.C.	2	041-345	1	
R104	RESISTOR 1K,½W,5%,C.C.	2	041-245	1	
R70,124	RESISTOR T & C			2	
R33,93	POTENTIOMETER 1K	5	044-309	2	
R56	POTENTIOMETER 5K	5	044-1019	1	
R42,107	POTENTIOMETER 10K	5	044-1055	2	

TABLE OF REPLACEABLE PARTS
CONTROL BOARD ASSEMBLY - STANDARD

P/L 17921-3

CIRCUIT REFERENCE	DESCRIPTION	MFG. CODE	AVTEL P/N	TQ	SP
R21,22,37	RESISTOR 10K,1/8W,1%,MF	4	045-1002	3	
R34	RESISTOR 20K,1/8W,1%,MF	4	045-2002	1	
R35	RESISTOR 100K,1/8W,1%,MF	4	045-1003	1	
R43	RESISTOR 47.5K,1/8W,1%,MF	4	045-4752	1	
R110,112	RESISTOR 30.1K,1/8W,1%,MF	4	045-3002	2	
R72	RESISTOR T & C,1/8W,1%,MF	4		1	
R73	RESISTOR T & C,1/8W,1%,MF	4		1	
R103	RESISTOR T & C,1/8W,1%,MF	4		1	
R111	RESISTOR T & C,1/8W,1%,MF	4		1	
R4	RESISTOR 2.2K,¼W,5%,C.C.	2	041-414	1	
R5,13,14,15,36,44, 46,51,65,74,76,82, 84,115	RESISTOR 10K,¼W,5%,C.C.	2	041-408	14	
R6,20,27,50,62,66, 123	RESISTOR 100K,¼W,5%,C.C.	2	041-1009	7	
R47,77	RESISTOR 4.7K,¼W,5%,C.C.	2	041-412	2	
R7	RESISTOR 330ohm,¼W,5%,C.C	2	041-427	1	
R8-10,30,57,59, 67,83,92	RESISTOR 2K,¼W,5%,C.C.	2	041-560	10	
R17,19,86,101,116,117	RESISTOR 30K,¼W,5%,C.C.	2	041-1007	6	
R40	RESISTOR 300K,¼W,5%,C.C.	2	041-1028	1	
R23,118	RESISTOR 4.7M,¼W,5%,C.C.	2	041-1026	2	
R24,122	RESISTOR 24K,¼W,5%,C.C.	2	041-750	1	
R25	RESISTOR 20K,¼W,5%,C.C.	2	041-508	2	
R26,45,48,75,78,99, 55,113,120	RESISTOR 1K,¼W,5%,C.C.	2	041-395	9	
R28,38,96	RESISTOR 1.5K,¼W,5%,C.C.	2	041-430	3	
R29	RESISTOR 200ohm,¼W,5%,C.C	2	041-740	1	
R31,80	RESISTOR 5.1K,¼W,5%,C.C.	2	041-561	2	

TABLE OF REPLACEABLE PARTS
CLOCK BOARD ASSEMBLY
SERIES - RESET - MASTER
P/N 18400-3

CIRCUIT REFERENCE	DESCRIPTION	MFG. CODE	AVTEL P/N	TQ	SP
Q101-137	TRANSISTOR 2N697	48	014-1045	37	
CR101-119	DIODE 1N914	48	013-1127	19	
C101,102,104,105, 106.107,109,110, 111,112,114,115, 116,117,119,120, 121,122,124,125, 126,127,129,130	CAPACITOR 250pf	24	034-1058	24	
C103,108,113,118 123,128	CAPACITOR .01uf	25	030-1010	6	
R101,105,109,113, 114,118,122,126, 127,131,135,139, 140,144,148,152, 153,157,161,178, 165,166,170,174	RESISTOR 39K	2	041-443	24	
R104,110,117,123, 130,136,143,149, 156,162,169,175	RESISTOR 3.9K	2	041-511	12	
R103,112,116,125, 129,138,180,142, 151,155,164,168, 177	RESISTOR 10K	2	041-408	13	
R107,120,133,146 159,172	RESISTOR 510ohm	2	041-504	6	
R102,111,115,124, 137,128,179,141, 150,154,163,167, 176	RESISTOR 1K	2	041-395	13	
R106,108,119,121, 132,134,145,147, 158,160,171,173,	RESISTOR 100K	2	041-1009	12	
C131	CAPACITOR T & C	24		1	

TABLE OF REPLACEABLE PARTS
CONVERTER ASSEMBLY

P/N 18151-1

CIRCUIT REFERENCE	DESCRIPTION	MFG. CODE	AVTEL P/N	TQ	SP
J201	CONNECTOR	88	169-1044	1	
CR201-206	DIODE	44	013-1066-8	6	
R201-203	RESISTOR 100ohm,½W,5%,CC	2	041-003	3	
R204	RESISTOR 47ohm,5%,2W,CC	2	041-1040	1	
C201	CAPACITOR .1uf,1000V	23	033-1134	1	
T201-203	TRANSFORMER	1	17993-1	3	

TABLE OF REPLACEABLE PARTS
INVERTER STRIP ASSEMBLY

P/N 18405

CIRCUIT REFERENCE	DESCRIPTION	MFG. CODE	AVTEL P/N	TQ	SP
CR1,2,5,6,9,10,13, 14,17,18,21,22	SCR - W/MTG. KIT	44	013-1066-4	12	
CR3,7,11,15,19,23	DIODE - W/MTG. KIT	44	013-1067	6	
CR4,8,12,16,20,24	DIODE - W/MTG. KIT	44	013-1067	6	
C1,2,4,5,7,8,10,11, 13,14,16,17	CAPACITOR .1ufd, 400V	23	033-1084	12	
C3A & B, 6A & B, 9A & B, 12A & B, 15A & B, 18A & B	CAPACITOR	46	035-1002	12	
T13-18	TRANSFORMER	1	16527-2	6	
L1-6	CHOKE	1	16530	6	
T1-6	TRANSFORMER	1	16531-2	6	
TH1	THERMOSTAT -W/MTG. HARD-WARE	66	021-007	1	
J1	CONNECTOR DA15P	88	169-1044	1	
R13-18	RESISTOR 180ohm,½W,±5%,CC	2	041-461	6	
R1-12	RESISTOR 47ohm,±5%,1W,CC	2	041-1036	12	

TABLE OF REPLACEABLE PARTS
CONNECTOR MOUNTING PLATE ASSEMBLY

P/L 18248-2

CIRCUIT REFERENCE	DESCRIPTION	MFG. CODE	AVTEL P/N	TQ	SP
C302	CAPACITOR 68uf, 15V	20	037-1026	1	
C301	CAPACITOR 100uf, 30V	23	037-1035	1	
R301	RESISTOR 25ohm, 10W	8	043-1079	1	
P301,302	CONNECTOR DA15S	88	169-1021	2	
J301-303	CONNECTOR	68	169-1071	3	
Q301	TRANSISTOR - W/INSUL. MTG. KIT	82	014-1070	1	
Q302	TRANSISTOR - W/INSUL. MTG. KIT	82	014-1057	1	
CR301,302	DIODE - W/INSUL. MTG. KIT	91	013-1070	2	
R302	RESISTOR 2K,½W,5%,C.C.	2	041-010	1	
CR304	DIODE 1N754A	40	013-1094	1	
CR305,306	DIODE CD1122	40	013-334	2	
T301	TRANSFORMER	1	17319-1	1	

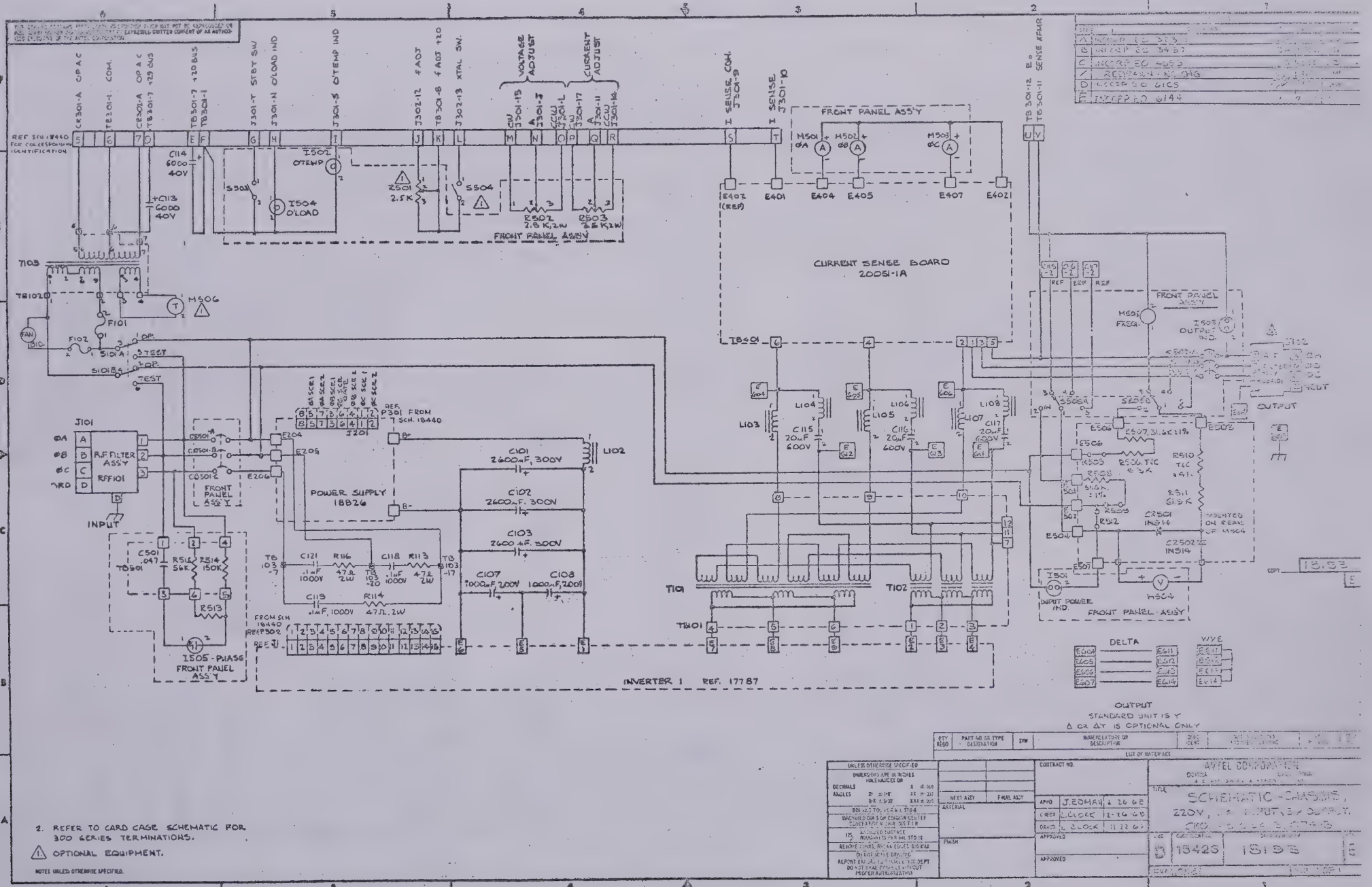
TABLE OF REPLACEABLE PARTS
CURRENT TRANSFORMER BOARD ASSEMBLY

P/L 18171-1

CIRCUIT REFERENCE	DESCRIPTION	MFG. CODE	AVTEL P/N	TQ	SP
CR401-409	DIODE CD1122	40	013-334	9	
R404,408,412	RESISTOR 680ohm,1W,3%	8	043-1140	3	
R403,407,411	RESISTOR T & C			3	
R402,406,410	RESISTOR 909ohm,1/8W,1%		045-9090	3	
R401,405,409	RESISTOR 30.1ohm,1/8W,1%		045-30R1	3	
C401,402,403	CAPACITOR 4.7uf, 35V	23	037-1009	3	
T401,402,403	TRANSFORMER	1	17559-1	3	

TABLE OF REPLACEABLE PARTS
CHASSIS

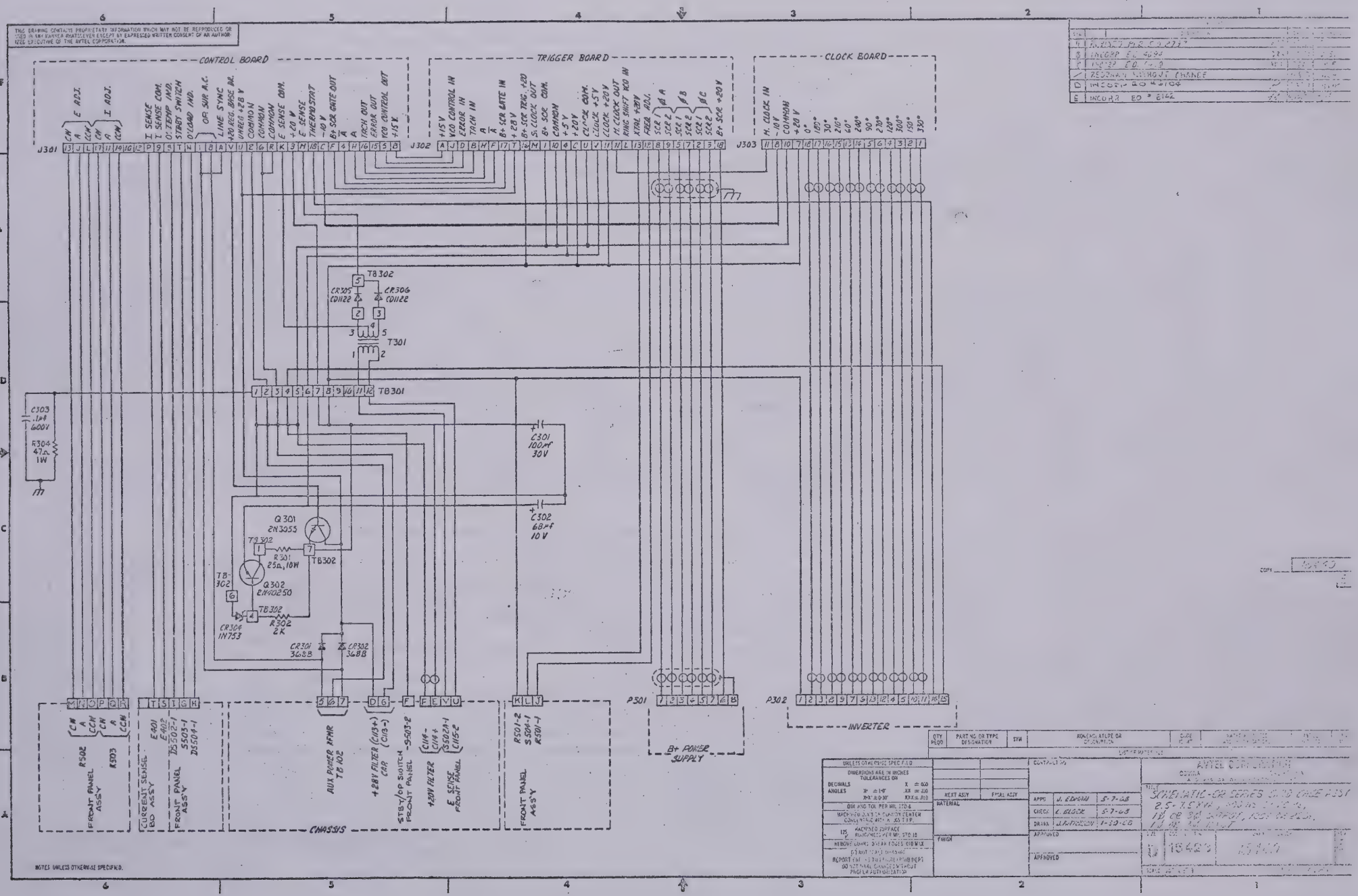
CIRCUIT REFERENCE	DESCRIPTION	MFG. CODE	AVTEL P/N	TQ	SP
F101,102	FUSE, 1A, S.B.	90	070-1010	2	
T103	TRANSFORMER	1	17321	1	
L104,106,108	CHOKE	1	17442	3	
L102	CHOKE	1	562-1049	1	
C107,108	CAPACITOR 1000uf, 200V	94	031-1056	2	
C101-103	CAPACITOR 2600uf, 300V	21	031-1055	3	
L103,105,107	CHOKE	1	17512	3	
C115,116,117	CAPACITOR 20uf, 600V	46	031-1053	3	
C113,114	CAPACITOR 6000uf, 40V	21	031-1007	2	
L101	CHOKE	1	18125	1	
RFF101	ASSY. FILTER	1	17500	1	
L1-3	CHOKE	1	17449	3	
C1-3	CAPACITOR 1uf, 600V	26	033-1096	3	
J1	CONNECTOR MS3102A-24-22P	88	169-1155	1	
S101,601	SWITCH	99	120-1018	12	
R601	RESISTOR 360ohm,1W,CC	2		1	
J102	CONNECTOR MS3102A-24-22S	88	169-1154	1	
TP1-12	TEST JACK	73	148-038	12	
R101-112	RESISTOR 1K,½W,CC	2	041-245	12	
C118,119,121	CAPACITOR .1uf, 1000V	23	033-1134	3	
R113,114,116	RESISTOR 47ohm,2W,CC	2	041-1021	3	
T101	TRANSFORMER	1	17511-4	1	



2. REFER TO CARD CAGE SCHEMATIC FOR 300 SERIES TERMINATIONS.

⚠ OPTIONAL EQUIPMENT.

NOTES UNLESS OTHERWISE SPECIFIED.



THIS DRAWING CONTAINS PROPRIETARY INFORMATION WHICH MAY NOT BE REPRODUCED OR USED IN ANY MANNER WHATSOEVER EXCEPT BY EXPRESSED WRITTEN CONSENT OF AN AUTHORIZED EXECUTIVE OF THE ANTEL CORPORATION.

LTR	DESCRIPTION	DATE	APPROVED
C	INCORP EC 4894	2-2-68	J.E.
B	INCORP EC 4703	1-30-68	J.E.
A	RELEASED WITHOUT CHANGE	1-19-68	J.E.
D	INCORP EC 4804	2-7-68	J.E.
E	INCORP EC # 6162	7-1-68	J.E.

NOTES UNLESS OTHERWISE SPECIFIED.

QTY REQD	PART NO. OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	SIZE	MATERIAL

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS X ± 0.0 XX ± 0.00 XXX ± 0.010
ANGLES ± 1/2°
DIR AND TOL PER MIL STD 8
MACHINED SURFACE ROUGHNESS PER MIL STD 10
REMOVE BURRS, SHARP EDGES AND MILK
DO NOT SCALE DRAWING
REPORT ERRORS IN PART NUMBERS OR EXTERNAL CONNECTIONS TO PROPER AUTHORIZATION

CONTRACT NO.
NEXT ASSY | FINAL ASSY
MATERIAL
FINISH

APPD	J. EDWIN	5-7-68
CHECK	L. BLOCK	5-7-68
DRAWN	J.A. PIGEON	1-30-68

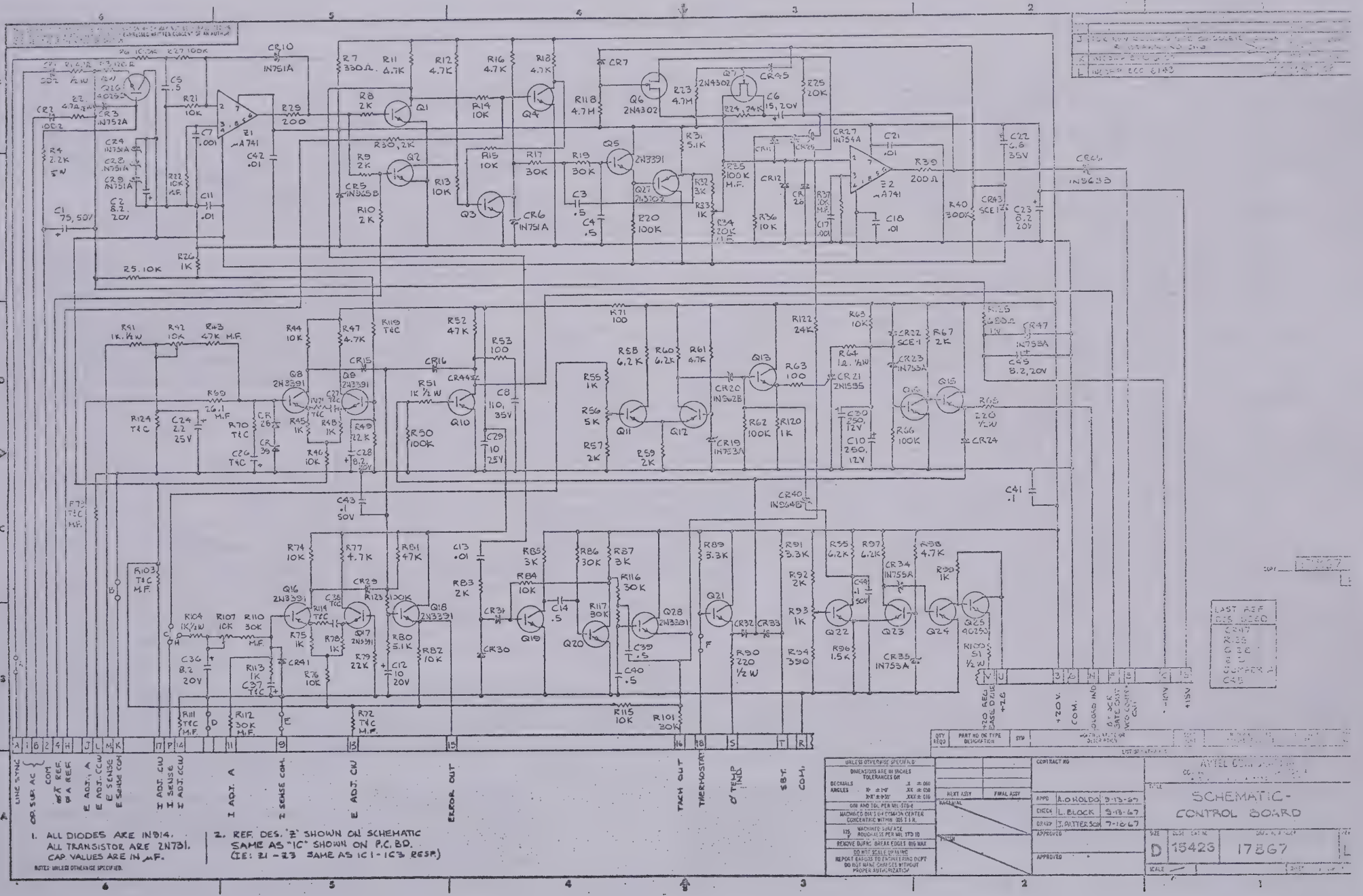
APPROVED
APPROVED

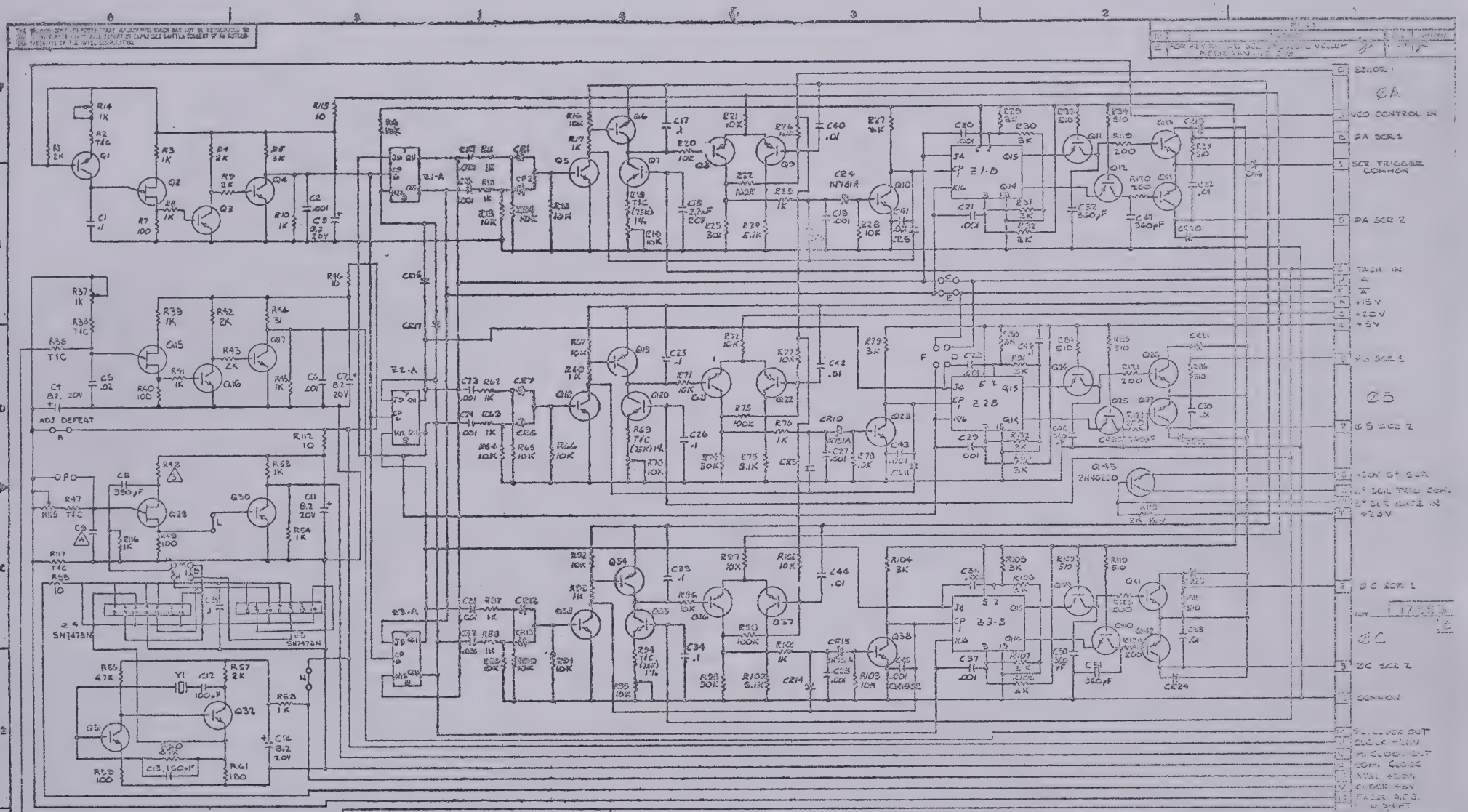
ANTEL CORPORATION
CANOGA PARK, CALIFORNIA

TITLE: SCHEMATIC-OR SERIES SCR CHOPPER 2.5-7.5 KW, 2000 CPS, 1Ø OR 3Ø INPUT, 400 CPS, 1Ø OUTPUT

SIZE D | DWG NO. 15402 | REV A

SCALE NONE | SHEET 1 OF 1


SCHEMATIC-
CONTROL BOARD
1. ALL DIODES ARE IN914.
ALL TRANSISTOR ARE 2N731.
CAP. VALUES ARE IN MF.
2. REF. DES. 'Z' SHOWN ON SCHEMATIC
SAME AS "IC" SHOWN ON P.C. BD.
(IE: Z1 - Z3 SAME AS IC1 - IC3 RESP.)
NOTES: UNLESS OTHERWISE SPECIFIED.
LINE SYNC
COM.
+20 V.
+15V
-15V
I ADJ. A
E ADJ. CW
ERROR OUT
THERMOSTAT
SET
COM.



⚠4 VALUE OF C9 IS .01mF FOR UNITS HAVING 12Ø CLOCK. OTHERWISE, C9 IS .02 mF.

3. ALL OTHER TRANSISTORS ARE 2N731.

2. TRANSISTORS: Q13,14,26,27,41 & 42 ARE 2N697, Q2,15, & 28 ARE 2N2646, Q1,6,8,9,19,21,22,34,36&37 ARE 2N3702, Q10,23, & 38 ARE 2N3904

1. ALL DIODES ARE IN914.

NOTES UNLESS OTHERWISE SPECIFIED.

7. REF. DES. "2" SHOWN ON SCHEMATIC SAME AS "1C" SHOWN ON P.C. BOARD (1C, 2I THRU 2A SAME AS 1C1 THRU 1C4 RESPECTIVELY).

6. FOR SINGLE Ø INPUT UNIT DELETE Z2 & Z3 AND ASSOCIATED CIRCUITRY.

⚠5 VALUE OF R48 IS 1K WITH FIXED CRYSTAL OPTIONS. OTHERWISE R48 IS 330 Ω.

MARK	WHEN USED/PURPOSE
A	FIXED UTT FREQ.
C,E	12K CLOCK FEEDBACK
F	20 MC XTAL FREQ. & CLOCK
N,R	5 MC XTAL FREQ. & CLOCK
L	NOT USED WITH 1C CLOCK
M	400 KC XTAL FREQ. & CLOCK
OBS	OBSOLETE, NOT USED

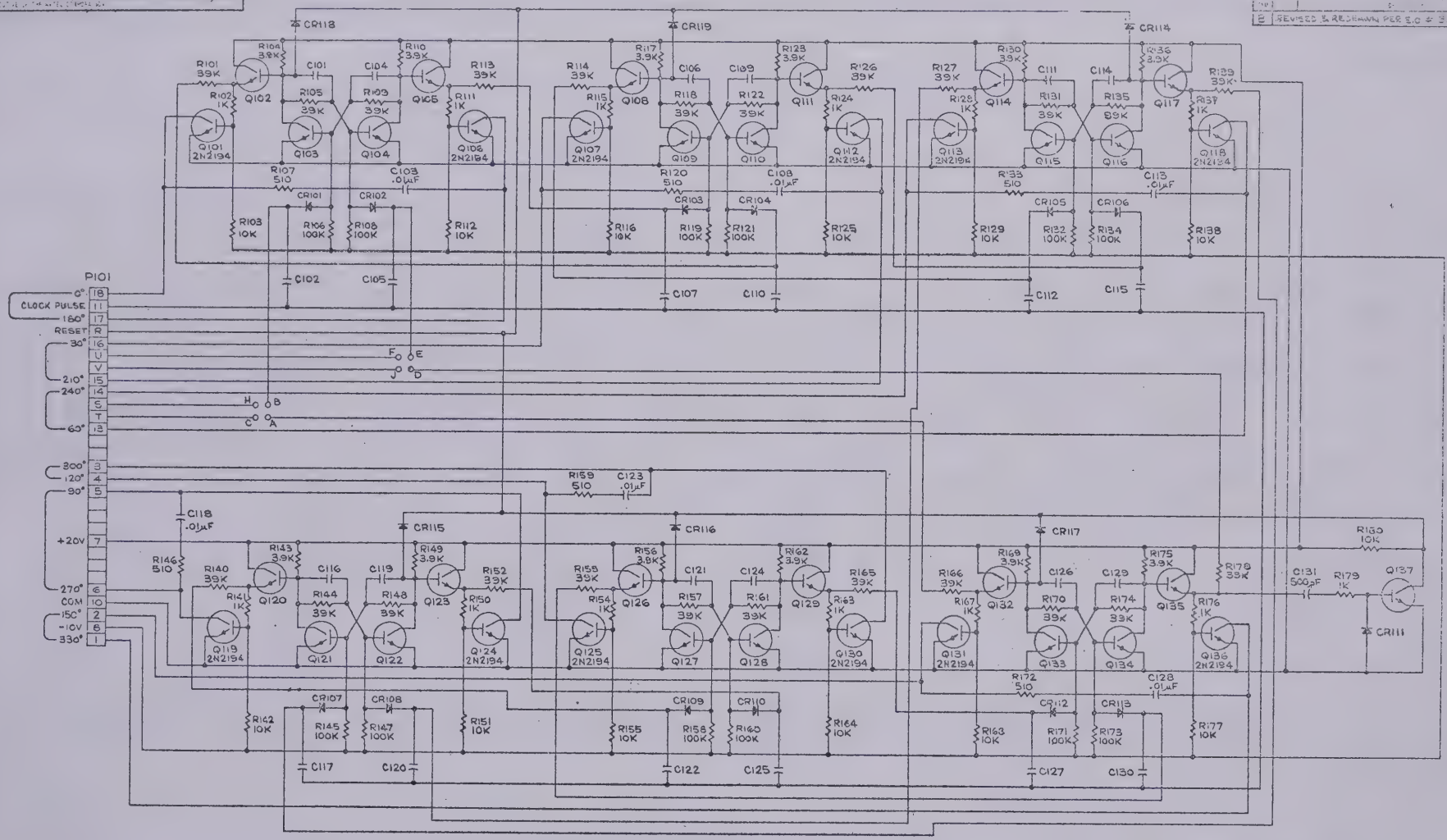
CONTRACT NO			
17017			
DRAWN	M.D. McLEOD	9-18-67	
CHECK	L. BLOCK	9-21-67	
APPROVED			
APPROVED			

AVTEL CORPORATION

SCHEMATIC - TRIGGER BOARD

SIZE	DRAWING NO.	REV.
D	15423	17833

SCALE NONE SHEET 1 OF 1



7. SLAVE, DELETE RESET CIRCUIT Q137, R179, R180, C131, & CR111.
6. SERIES CLOCK (MASTER OR SLAVE): A-C, B-H, D-J, E-F JUMPERS.
5. SINGLE CLOCK : A-B, D-E JUMPERS.
4. ALL TRANSISTORS ARE 2N697.
3. ALL CAPACITORS ARE 250 pF.
2. ALL DIODES ARE IN914.
1. ALL RESISISTORS IN OHMS, 1/4W, ±5%, C.C.

NOTES UNLESS OTHERWISE SPECIFIED

QTY REQ	PART NO OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ± .100 .XX ± .030 .XXX ± .010
ANGLES 30' ± 1°0' XX ± 30' XXX ± 10'
DIM AND TOL PER MIL STD 8
MACHINED & FOR COMMON CENTER CONCENTRIC WITHIN .XXX T I R
MACHINED SURFACE ROUGHNESS PER MIL STD 10
REMOVE BURRS BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT
DO NOT MAKE CHANGES WITHOUT PROPER AUTHORIZATION

NEXT ASSY | FINAL ASSY
MATERIAL
FINISH

CONTRACT NO

AVTEL CORPORATION
COVINA

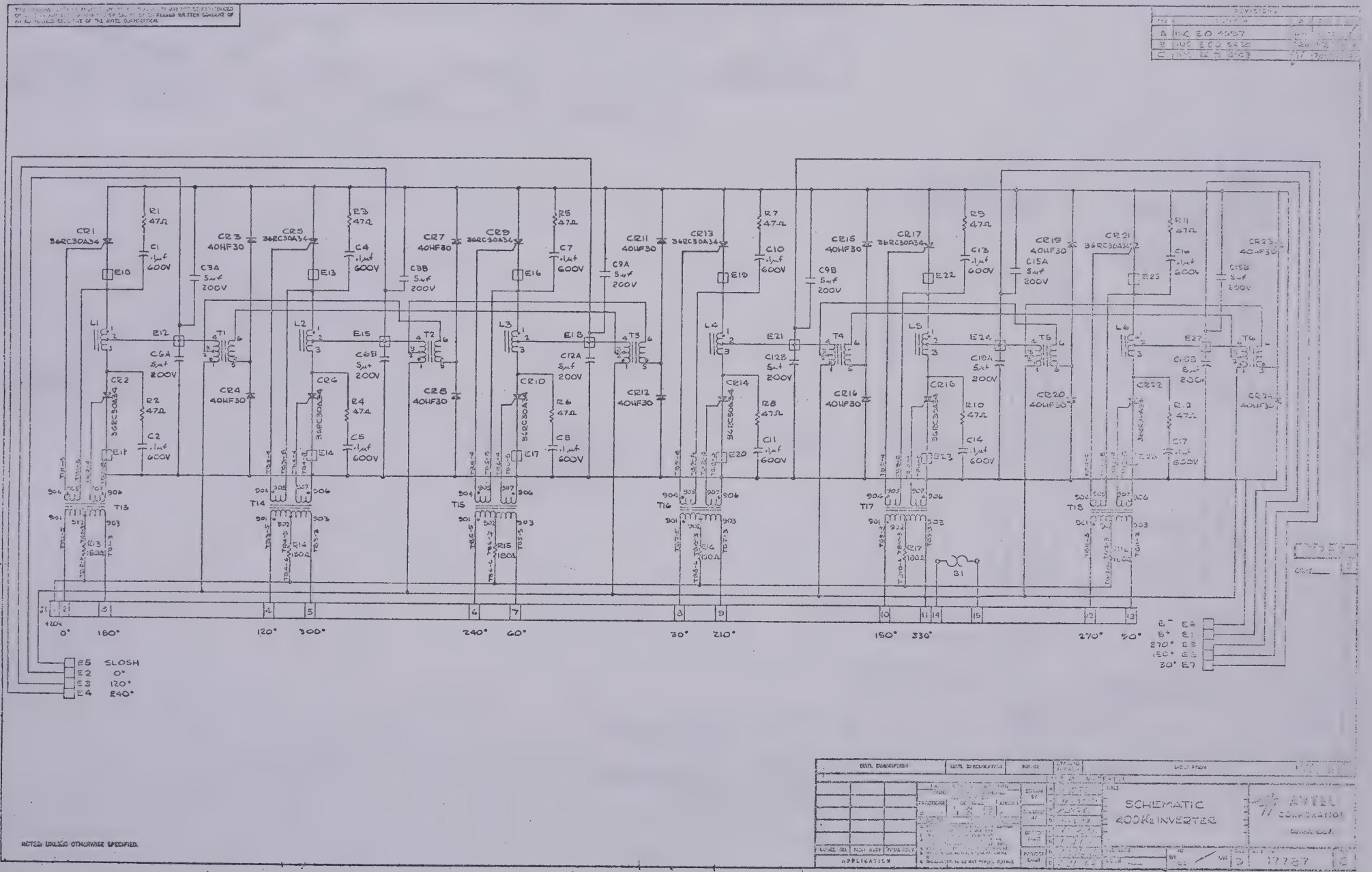
APPD	J. EDMAN	1-25-68
CHECK	J. EDMAN	1-28-68
DRAWN	L. BLOCK	4-21-66

APPROVED
APPROVED

TITLE
SCHEMATIC
CLOCK CIRCUIT RESET

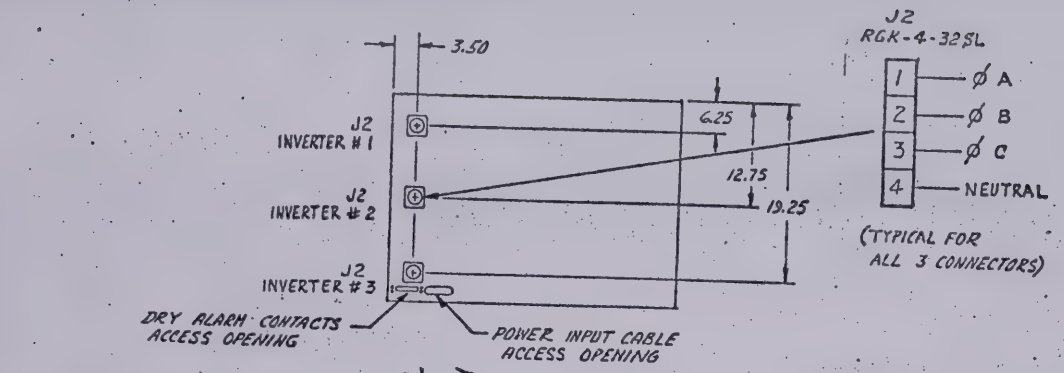
SIZE D | CAGE CODE 15423 | DRAWING NO 18389 | REV B

SCALE | WEIGHT | SHEET

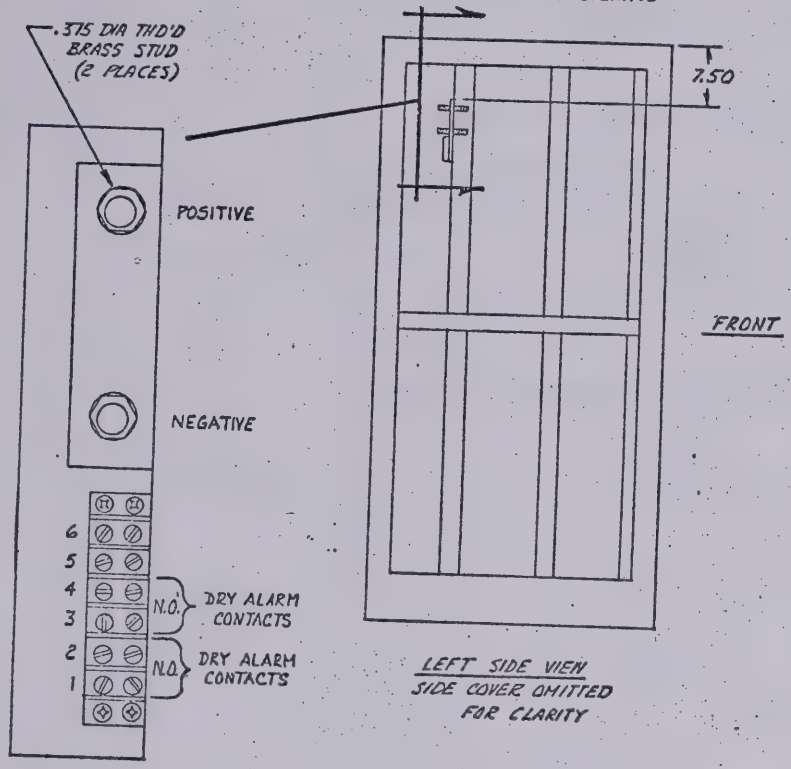


NOTES: UNLESS OTHERWISE SPECIFIED.

SYM	DESCRIPTION	DATE	AP



(TYPICAL FOR ALL 3 CONNECTORS)



FRONT

LEFT SIDE VIEW
SIDE COVER OMITTED FOR CLARITY

RACK DIMENSIONS

HEIGHT : 84 INCHES
WIDTH : 25 3/8 INCHES
DEPTH : 36 INCHES

COPY 24057

QTY REQD	PART NO. OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL, NOTES AND SPECIFICATIONS	AVTEL PART NO.	ITEM NO.

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±.060 .XX ±.030 .XXX ±.010
ANGLES X° ±1°0' X°X' ±0°30'
DIM. AND TOL PER MIL-STD 8
MACHINED DIA'S ON COMMON CENTER CONCENTRIC WITHIN .005 T.I.R.
125 MACHINED SURFACE ROUGHNESS PER MIL STD 10
REMOVE BURRS, BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT
DO NOT MAKE CHANGES WITHOUT PROPER AUTHORIZATION

NEXT ASSY | FINAL ASSY

MATERIAL

FINISH

CONTRACT NO.

APPD	J.W.	10/27/70
CHECK		
DRAWN	W.R. Nash	10-27-70

APPROVED

APPROVED

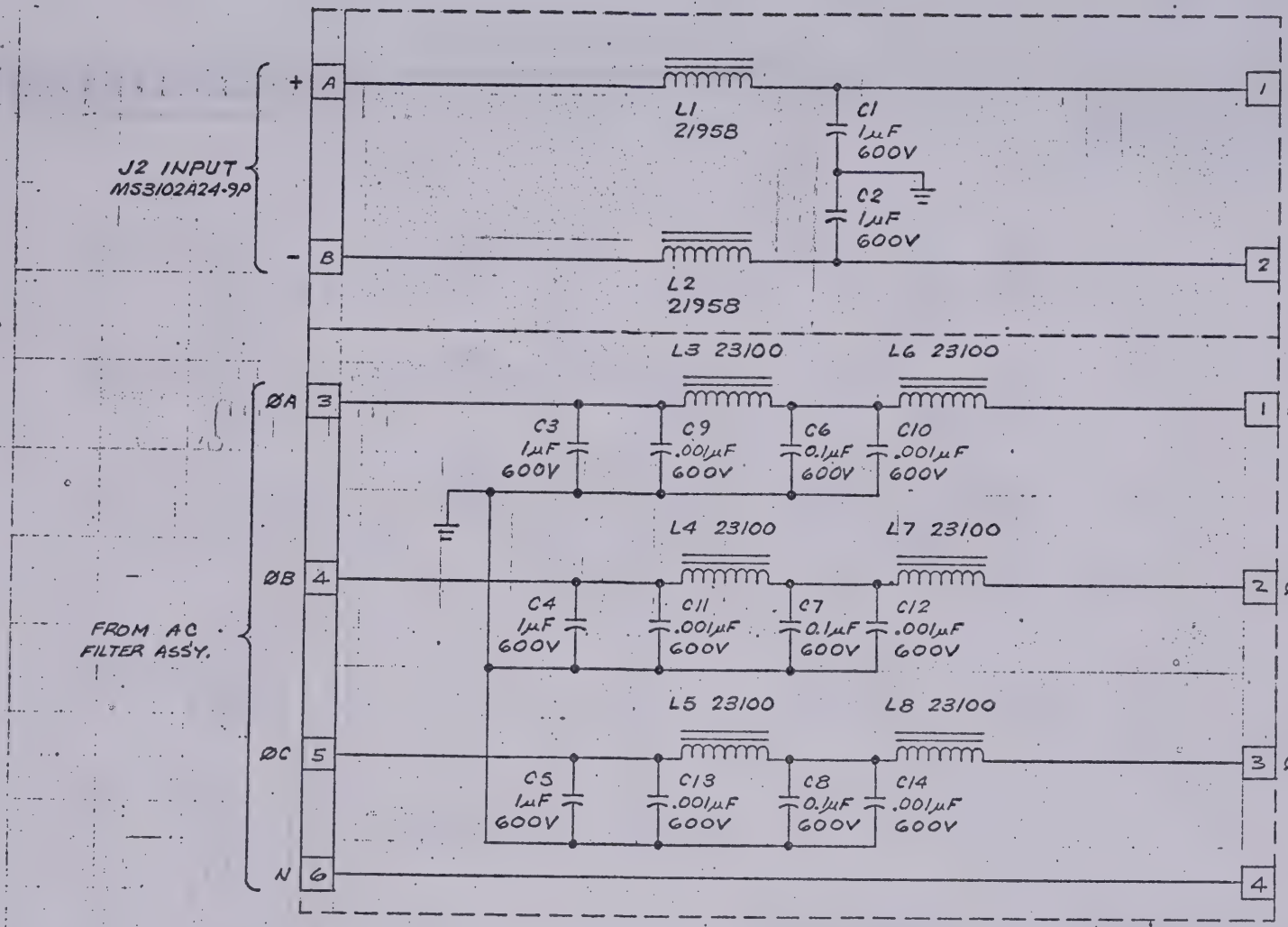
AVTEL CORPORATION
COVINA CALIFORNIA
A DIVISION OF AIRTRONICS, INC.

TITLE
INSTALLATION DRAWING -
3 Ø WYE, 400 Hz, 5 KVA
REDUNDANT FREQ. CHANGER

SIZE	CODE IDENT NO.	DRAWING NUMBER	REV.
C	15423	24057	

NOTES: UNLESS OTHERWISE SPECIFIED.

SYM	DESCRIPTION	DATE	APPD
A	PROD. RELEASE, C.O. 5744	1-7-70	J.W.



COPY 23920

QTY REQD	PART NO. OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL, NOTES AND SPECIFICATIONS	AVTEL PART NO.

LIST OF MATERIALS

1. REF FILTER ASSY DWG NO. 23605

NOTES: UNLESS OTHERWISE SPECIFIED.

UNLESS OTHERWISE SPECIFIED.
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±.050
ANGLES X° ±1°0' .XX ±.030
X°X' ±0°30' .XXX ±.010
DIM. AND TOL PER MIL-STD 8
MACHINED DIA'S ON COMMON CENTER CONCENTRIC WITHIN .005 T.I.R.
125 MACHINED SURFACE ROUGHNESS PER MIL STD 10
REMOVE BURRS, BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT.
DO NOT MAKE CHANGES WITHOUT PROPER AUTHORIZATION

23605	23016
NEXT ASSY	FINAL ASSY

MATERIAL

FINISH

CONTRACT NO.

APPD	J.W.	
CHECK		
DRAWN	DRH	10-5-70

APPROVED

APPROVED

AVTEL CORPORATION
COVINA CALIFORNIA
A DIVISION OF AIRTRONICS, INC.

TITLE
SCHEMATIC DIAGRAM
INPUT/OUTPUT RFI FILTER

SIZE	CODE IDENT NO.	DRAWING NUMBER
C	15423	23920

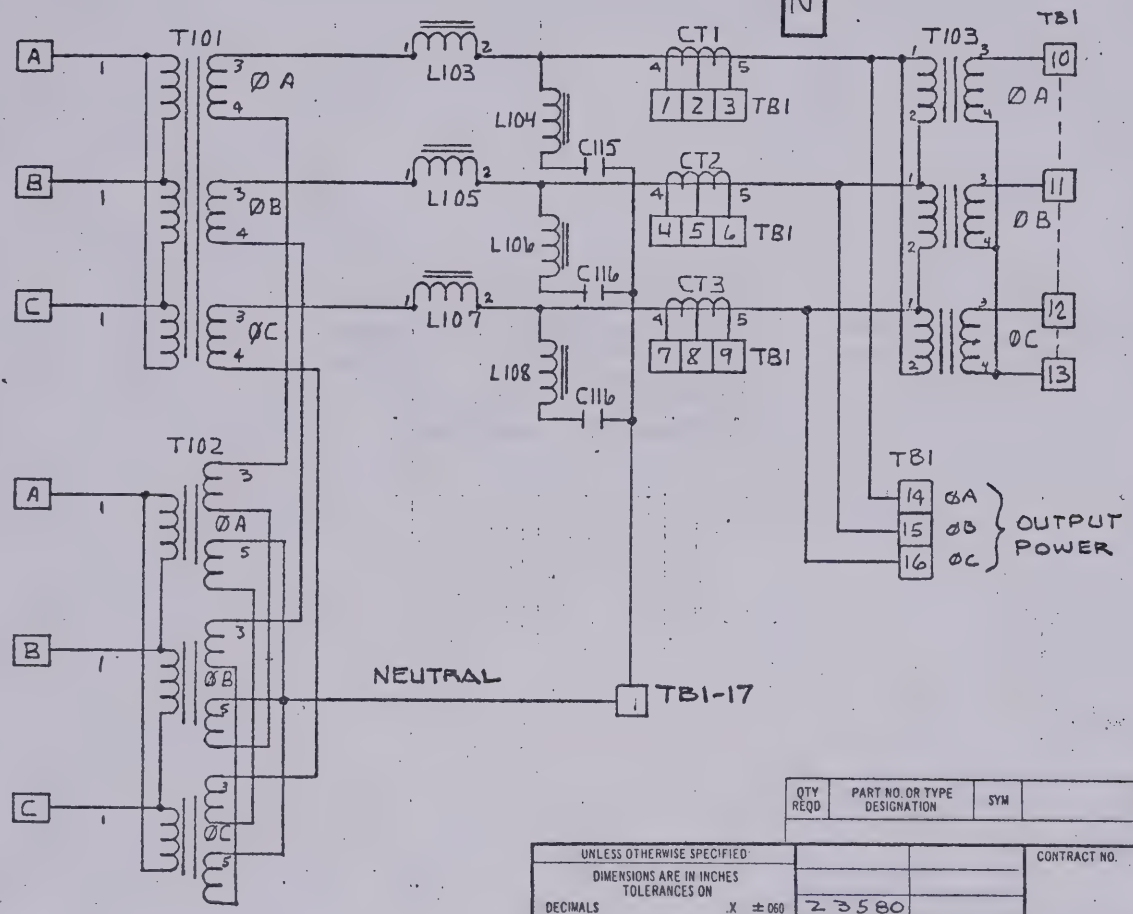
SCALE

SHEET 1 OF 1

THIS DRAWING CONTAINS PROPRIETARY INFORMATION WHICH MAY NOT BE REPRODUCED OR USED IN ANY MANNER WHATSOEVER EXCEPT BY EXPRESSED WRITTEN CONSENT OF AN AUTHORIZED EXECUTIVE OF THE AVTEL CORPORATION.

REVISIONS				
SYM		DESCRIPTION	DATE	APPROV
A		PROD. RELEASE, EO 5744	11/5/70	J.L

23767 A



QTY REQD	PART NO. OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL, NOTES AND SPECIFICATIONS	AVTEL PART NO

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±.060
ANGLES X° ±1°0' .XX ±.030
X°X' ±0°30' .XXX±.010
DIM. AND TOL PER MIL-STD-8
MACHINED DIA'S ON COMMON CENTER CONCENTRIC WITHIN .005 T.I.R.
125 MACHINED SURFACE ROUGHNESS PER MIL-STD-10
REMOVE BURRS, BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT
DO NOT MAKE CHANGES WITHOUT PROPER AUTHORIZATION

23580
NEXT ASSY | FINAL ASSY
MATERIAL
FINISH

CONTRACT NO.

APPD	J.W.	
CHECK		
DRAWN	G.C.	9-1-70
APPROVED		
APPROVED		

AVTEL CORPORATION
COVINA CALIFORNIA
A DIVISION OF AIRTRONICS, INC.

TITLE SCHEMATIC- OUTPUT FILTER ASSEMBLY

SIZE	CODE IDENT NO.	DRAWING NUMBER	
B	15423	23767	A

SCALE | SHEET

NOTES UNLESS OTHERWISE SPECIFIED.

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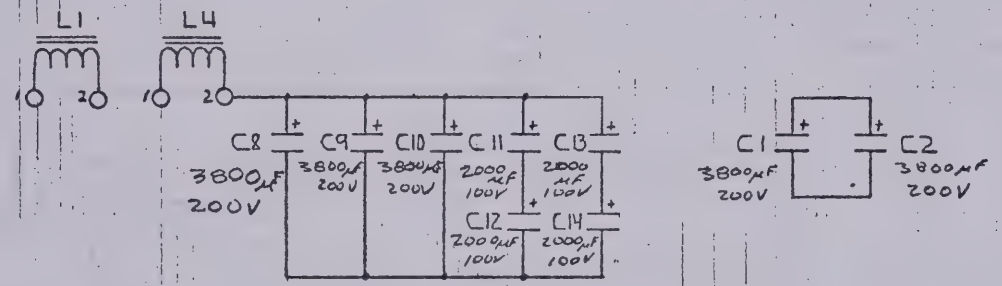
REVISIONS				
SYM		DESCRIPTION	DATE	APPRD.
A		PROD. RELEASE, EO 5744	11/5/75	J.

23764 A

COPY



QTY REQD	PART NO. OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL NOTES AND SPECIFICATIONS	AVTEL PART NO	IT

LIST OF MATERIALS

NOTES, UNLESS OTHERWISE SPECIFIED.

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±.060
ANGLES X° ±1°0' .XX ±.030
X°X' ±0°30' .XXX±.010
DIM. AND TOL PER MIL-STD-8
MACHINED DIA'S ON COMMON CENTER CONCENTRIC WITHIN .005 T.I.R.
125 MACHINED SURFACE ROUGHNESS PER MIL-STD-10
REMOVE BURRS, BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT
DO NOT MAKE CHANGES WITHOUT PROPER AUTHORIZATION

23795
NEXT ASSY. | FINAL ASSY
MATERIAL
FINISH

CONTRACT NO.

APPD	J. W.	
CHECK		
DRAWN	[illegible]	9.1.75
APPROVED		
APPROVED		

AVTEL CORPORATION
COVINA CALIFORNIA
A DIVISION OF AIRTRONICS INC.

TITLE SCHEMATIC - D.C. FILTER PLATE

SIZE	CODE IDENT NO.	DRAWING NUMBER	RE
B	15423	23764	A

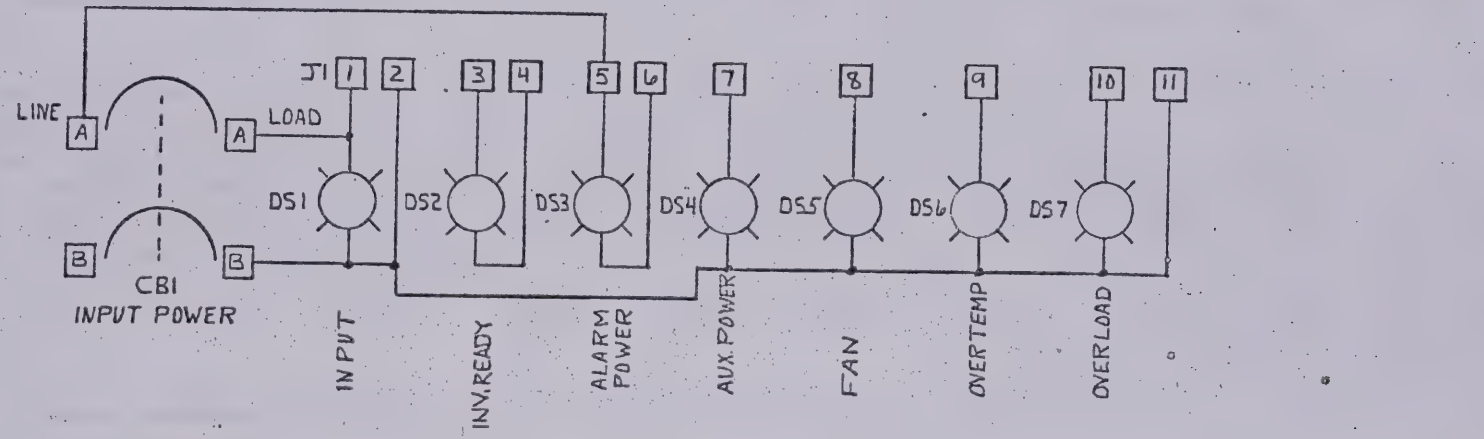
SCALE | SHEET

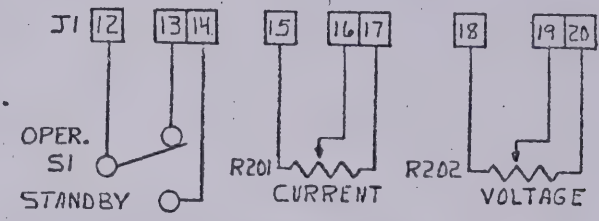
THIS DRAWING CONTAINS PROPRIETARY INFORMATION WHICH MAY NOT BE REPRODUCED OR USED IN ANY MANNER WHATSOEVER EXCEPT BY EXPRESSED WRITTEN CONSENT OF AN AUTHORIZED EXECUTIVE OF THE AVTEL CORPORATION.

23789 A

COPY

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVE
A	PROD, RELEASE, EO 5744	11/5/70	J, W





QTY REQD	PART NO. OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL NOTES AND SPECIFICATIONS	AVTEL PART NO	ITE NO

LIST OF MATERIALS

NOTES UNLESS OTHERWISE SPECIFIED.

UNLESS OTHERWISE SPECIFIED.
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±.060
ANGLES X° ±1°0' .XX ±.030
X°X' ±0°30' .XXX ±.010
DIM. AND TOL PER MIL-STD-8
MACHINED DIA'S ON COMMON CENTER CONCENTRIC WITHIN .005 T.I.R.
125 MACHINED SURFACE ROUGHNESS PER MIL STD 10
REMOVE BURRS, BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT
DO NOT MAKE CHANGES WITHOUT PROPER AUTHORIZATION

23628
NEXT ASSY | FINAL ASSY
MATERIAL
FINISH

CONTRACT NO.

APPD	J, W	
CHECK		
DRAWN	[illegible]	9-3-70
APPROVED		
APPROVED		

AVTEL CORPORATION
COVINA CALIFORNIA
A DIVISION OF AIRTRONICS, INC.

TITLE
SCHEMATIC-
STATUS & ALARM PANEL

SIZE	CODE IDENT NO.	DRAWING NUMBER	REV
B	15423	23789	A

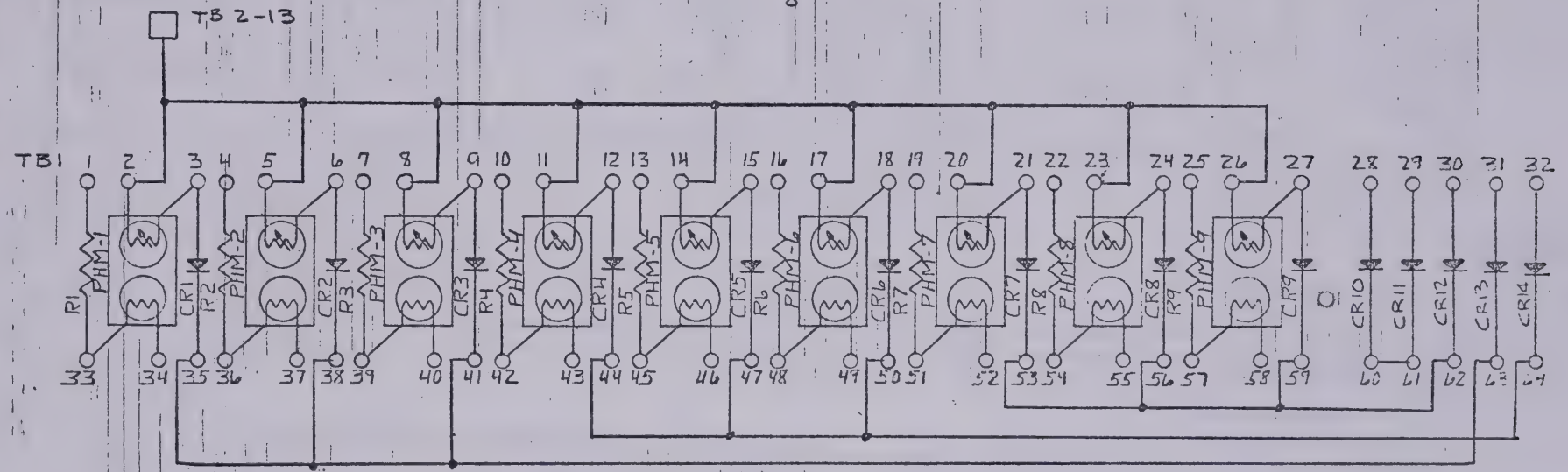
SCALE
SHEET

THIS DRAWING CONTAINS PROPRIETARY INFORMATION WHICH MAY NOT BE REPRODUCED OR USED IN ANY MANNER WHATSOEVER EXCEPT BY EXPRESSED WRITTEN CONSENT OF AN AUTHORIZED EXECUTIVE OF THE AVTEL CORPORATION.

REVISIONS				
SYM		DESCRIPTION	DATE	APPROVE
A		PROD! RELEASE; EO 5744	11/8/72	J.W.

23793 A

COPY



2. ALL DIODES ARE IN4005

1. ALL RESISTORS ARE 91K, 1/2W, ±5%, C.C.

NOTES UNLESS OTHERWISE SPECIFIED.

QTY REQD	PART NO OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL NOTES AND SPECIFICATIONS	AVTEL PART NO	ITE NO

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±.060
ANGLES X° ±1°0' .XX ±.030
X°X' ±0°30' .XXX±.010
DIM. AND TOL PER MIL-STD-8
MACHINED DIA'S ON COMMON CENTER CONCENTRIC WITHIN .005 T.I.R.
125 MACHINED SURFACE ROUGHNESS PER MIL STD 10
REMOVE BURRS, BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT
DO NOT MAKE CHANGES WITHOUT PROPER AUTHORIZATION

23785
NEXT ASSY | FINAL ASSY
MATERIAL
FINISH

CONTRACT NO.

APPD	J.W.	
CHECK		
DRAWN	[illegible]	7-4-70
APPROVED		
APPROVED		

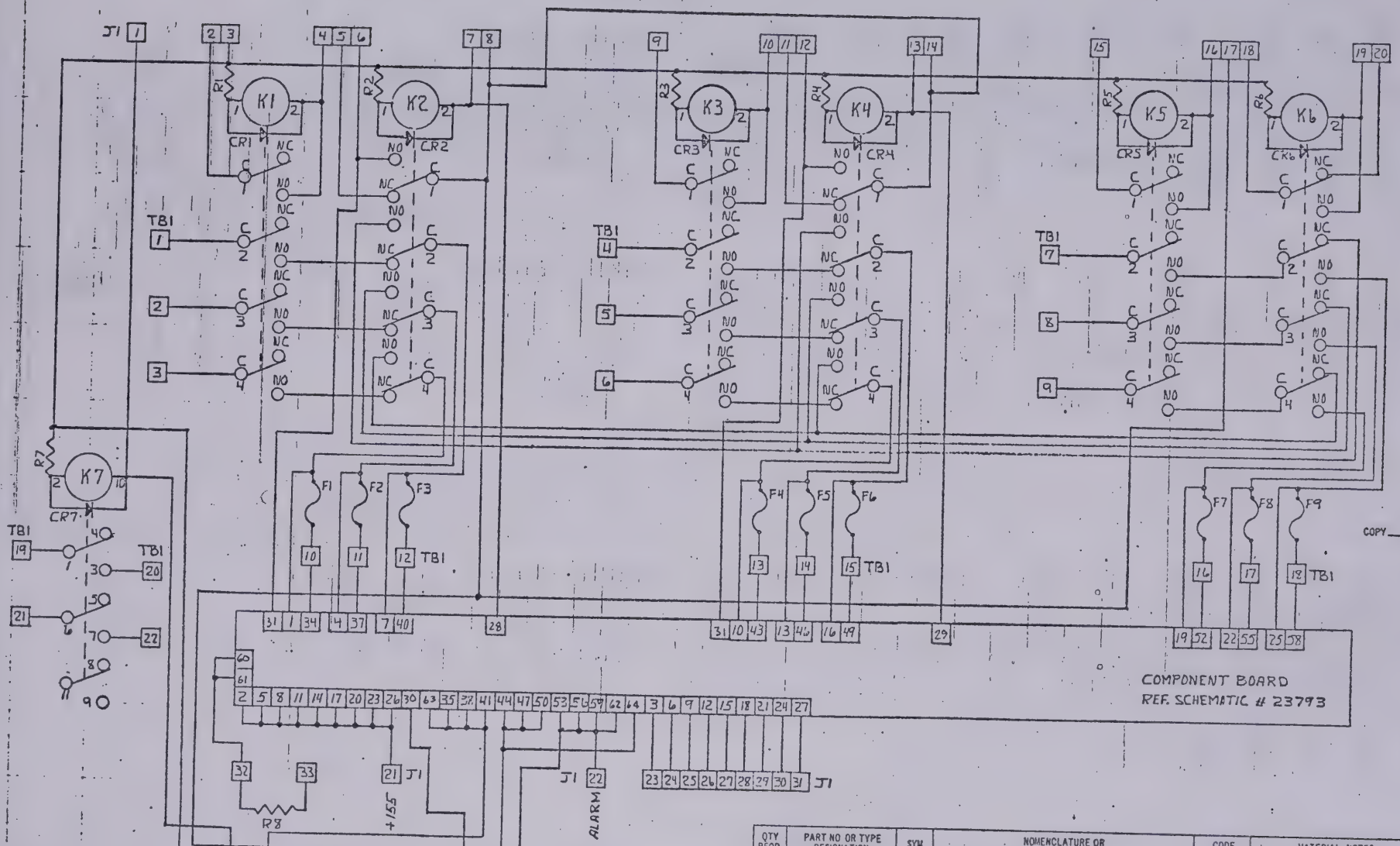
AVTEL CORPORATION
COVINA CALIFORNIA
A DIVISION OF AIRTRONICS, INC.

TITLE SCHEMATIC - COMPONENT BOARD - RELAY PANEL

SIZE	CODE IDENT NO	DRAWING NUMBER	REV
B	15423	23793	A

SCALE | SHEET

A	PROD. RELEASE E.O. 5744	11/5/70	J. L.



COPY 23798 A

NOTES: UNLESS OTHERWISE SPECIFIED.

QTY REQD	PART NO OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL, NOTES AND SPECIFICATIONS	AVTEL PART NO.	ITEM NO

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED.
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±.060 .XX ±.030 .XXX±.010
ANGLES X° ±1°0' X°X' ±0°30'
DIM AND TOL PER MIL-STD-8
MACHINED DIA'S ON COMMON CENTER CONCENTRIC WITHIN .005 T.I.R.
125 MACHINED SURFACE ROUGHNESS PER MIL STD 10
REMOVE BURRS BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT
DO NOT MAKE CHANGES WITHOUT PROPER AUTHORIZATION

23607
NEXT ASSY | FINAL ASSY
MATERIAL
FINISH

CONTRACT NO.

APPD	J.W.	
CHECK		
DRAWN	[illegible]	7-8-70
APPROVED		
APPROVED		

AVTEL CORPORATION
COVINA CALIFORNIA
A DIVISION OF AIRTRONICS, INC.

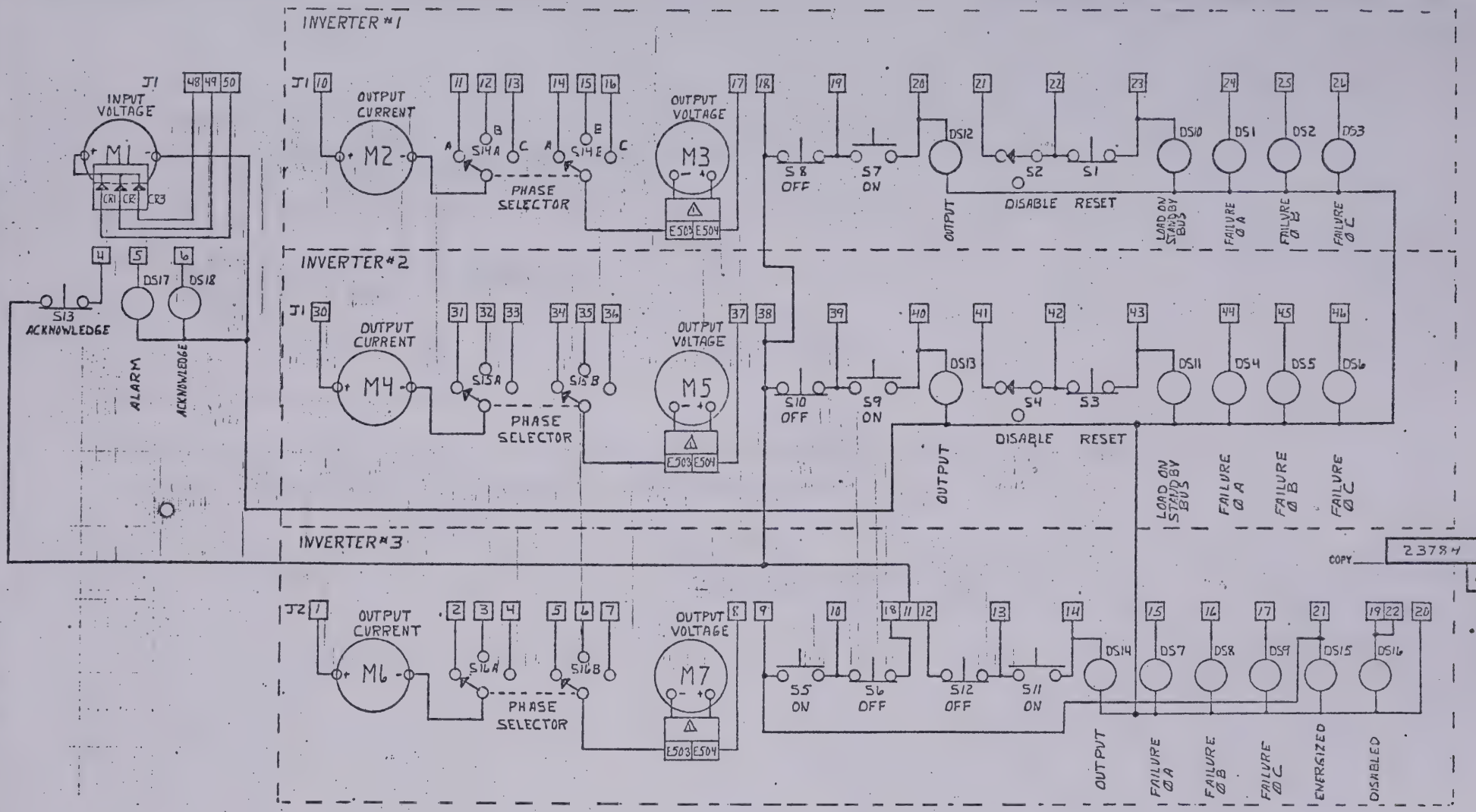
TITLE
SCHEMATIC-
RELAY PANEL

SIZE	CODE IDENT NO.	DRAWING NUMBER	REV.
C	15423	23798	A

SCALE SHEET

IZED EXECUTIVE OF THE AVTEL CORPORATION.

SYM	DESCRIPTION	DATE	APPROV
A	PROD. RELEASE, E.O. 5744	11/5/70	J.W.

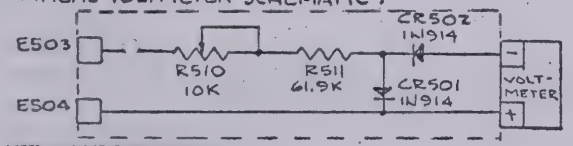


COPY 23784

QTY REQD	PART NO. OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL, NOTES AND SPECIFICATIONS	AVTEL PART NO.	IT NO

LIST OF MATERIALS

⚠ TYPICAL VOLTMETER SCHEMATIC:



NOTES UNLESS OTHERWISE SPECIFIED.

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±.060
ANGLES X- ±1°0' .XX ±.030
X-X'±0°30' .XXX±.010
DIM. AND TOL PER MIL-STD 8
MACHINED DIA'S ON COMMON CENTER CONCENTRIC WITHIN .005 T.I.R.
125 MACHINED SURFACE ROUGHNESS PER MIL STD 10
REMOVE BURRS, BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT
DO NOT MAKE CHANGES WITHOUT PROPER AUTHORIZATION

23637
NEXT ASSY | FINAL ASSY
MATERIAL
FINISH

CONTRACT NO.

APPD J.W.
CHECK
DRAWN J.W. 6-2-70
APPROVED
APPROVED

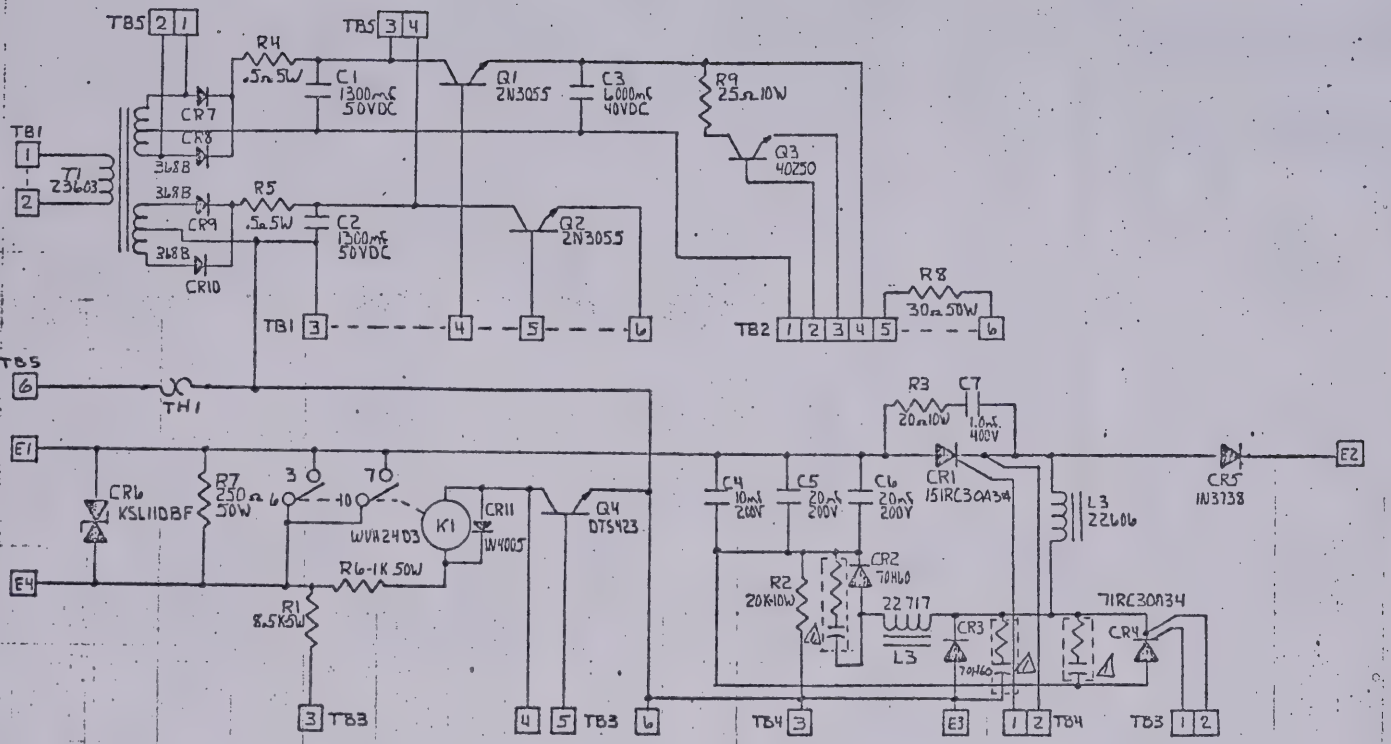
AVTEL CORPORATION
COVINA CALIFORNIA
A DIVISION OF AIRTRONICS, INC.

TITLE
SCHEMATIC-
SYSTEM CONTROL

SIZE	CODE IDENT NO.	DRAWING NUMBER	RE
C	15423	23784	A

SCALE SHEET

SYM	DESCRIPTION	DATE	APPRVD
A	PROD. RELEASE, ECO 5744	11/5/70	J.W.



COPY 23761

QTY REQD	PART NO. OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL, NOTES AND SPECIFICATIONS	AVTEL PART NO.

LIST OF MATERIALS

Δ Ass'y. 24000-1 + CAP. 0.1 μF, 600V; RES. 47Ω, 1W, C.C.

NOTES: UNLESS OTHERWISE SPECIFIED.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±.060
ANGLES X° ±1°0' .XX ±.030
X°X' ±0°30' .XXX ±.010
DIM. AND TOL PER MIL-STD 8
MACHINED DIA'S ON COMMON CENTER CONCENTRIC WITHIN .005 T.I.R.
125 MACHINED SURFACE ROUGHNESS PER MIL STD 10
REMOVE BURRS, BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT
DO NOT MAKE CHANGES WITHOUT PROPER AUTHORIZATION

23604
NEXT ASSY | FINAL ASSY
MATERIAL
FINISH

CONTRACT NO.

APPD	J.W.	
CHECK		
DRAWN	A.J.C.	9-1-70
APPROVED		
APPROVED		

AVTEL CORPORATION
COVINA CALIFORNIA
A DIVISION OF AIRTRONICS, INC.

TITLE
SCHEMATIC-
CHOPPER POWER SECTION

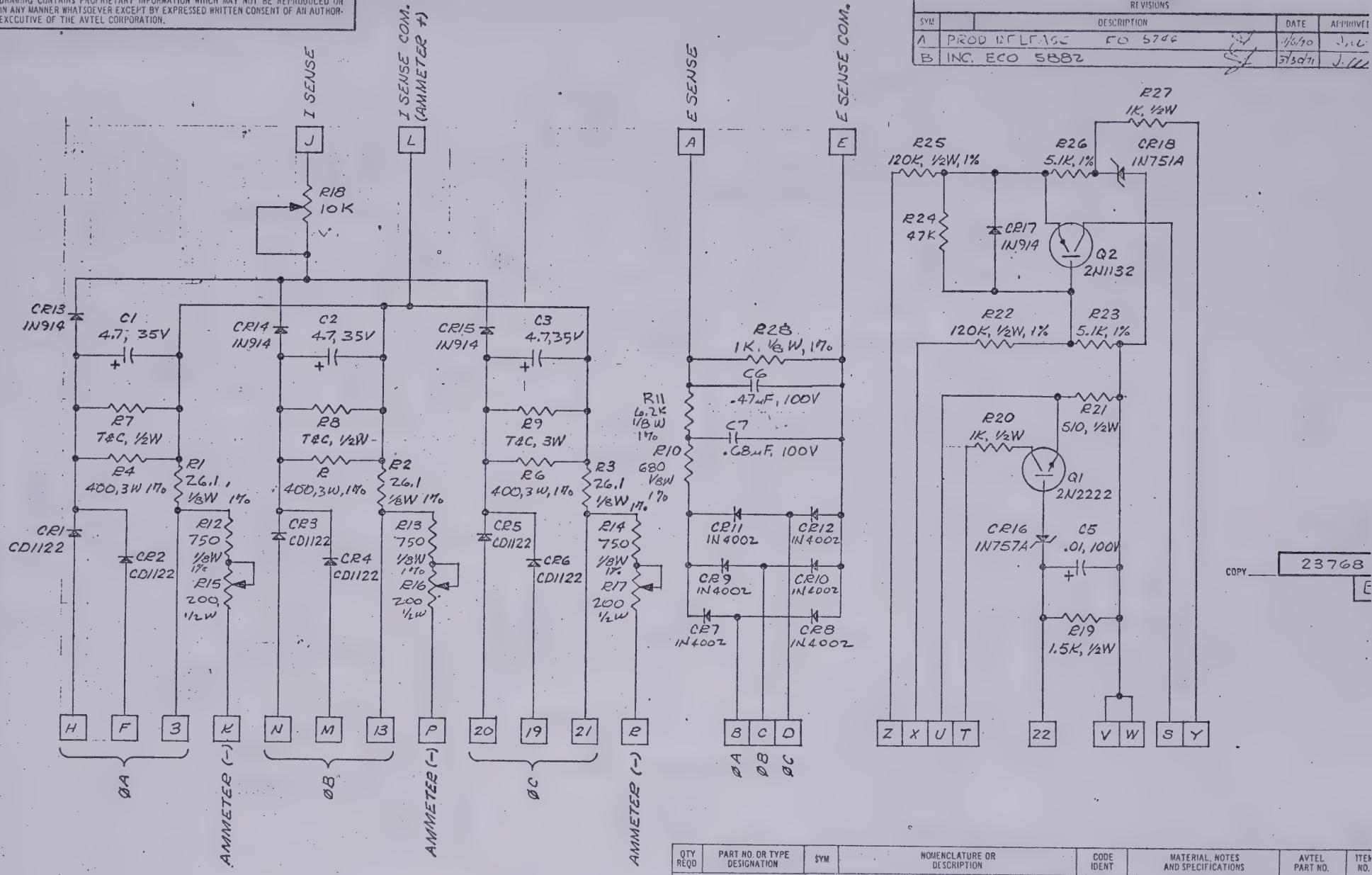
SIZE	CODE IDENT NO.	DRAWING NUMBER	REV
C	15423	23761	A

SCALE | SHEET

THIS DRAWING CONTAINS PROPRIETARY INFORMATION WHICH MAY NOT BE REPRODUCED OR USED IN ANY MANNER WHATSOEVER EXCEPT BY EXPRESSED WRITTEN CONSENT OF AN AUTHORIZED EXCCUTIVE OF THE AVTEL CORPORATION.

REVISIONS

SYM	DESCRIPTION	DATE	APPROVED
A	PROD RELEASE ECO 5766	4/6/70	J.W.
B	INC. ECO 5882	5/3/71	J.W.



COPY 23768 E

QTY REQD	PART NO. OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL, NOTES AND SPECIFICATIONS	AVTEL PART NO.	ITEM NO.

LIST OF MATERIALS

2. ALL CAPACITANCE IN MICROFARADS.
1. ALL RESISTANCES IN OHMS, ¼W, ±5%.

NOTES: UNLESS OTHERWISE SPECIFIED.

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±.060
ANGLES X° ±1°0' .XX ±.030
X°X' ±0°30' XXX ±.010
DIM AND TOL PER MIL-STD-8
MACHINED DIA'S ON COMMON CENTER CONCENTRIC WITHIN .005 T.I.R.
125 MACHINED SURFACE ROUGHNESS PER MIL STD 10
REMOVE BURRS, BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT
DO NOT MAKE CHANGES WITHOUT PROPER AUTHORIZATION

NEXT ASSY	FINAL ASSY
23771	23016

MATERIAL
FINISH

CONTRACT NO.

APPD	J.W.	
CHECK		
DRAWN	DKH	9-8-70

APPROVED
APPROVED

AVTEL CORPORATION
COVINA CALIFORNIA
A DIVISION OF AIRTRONICS, INC.

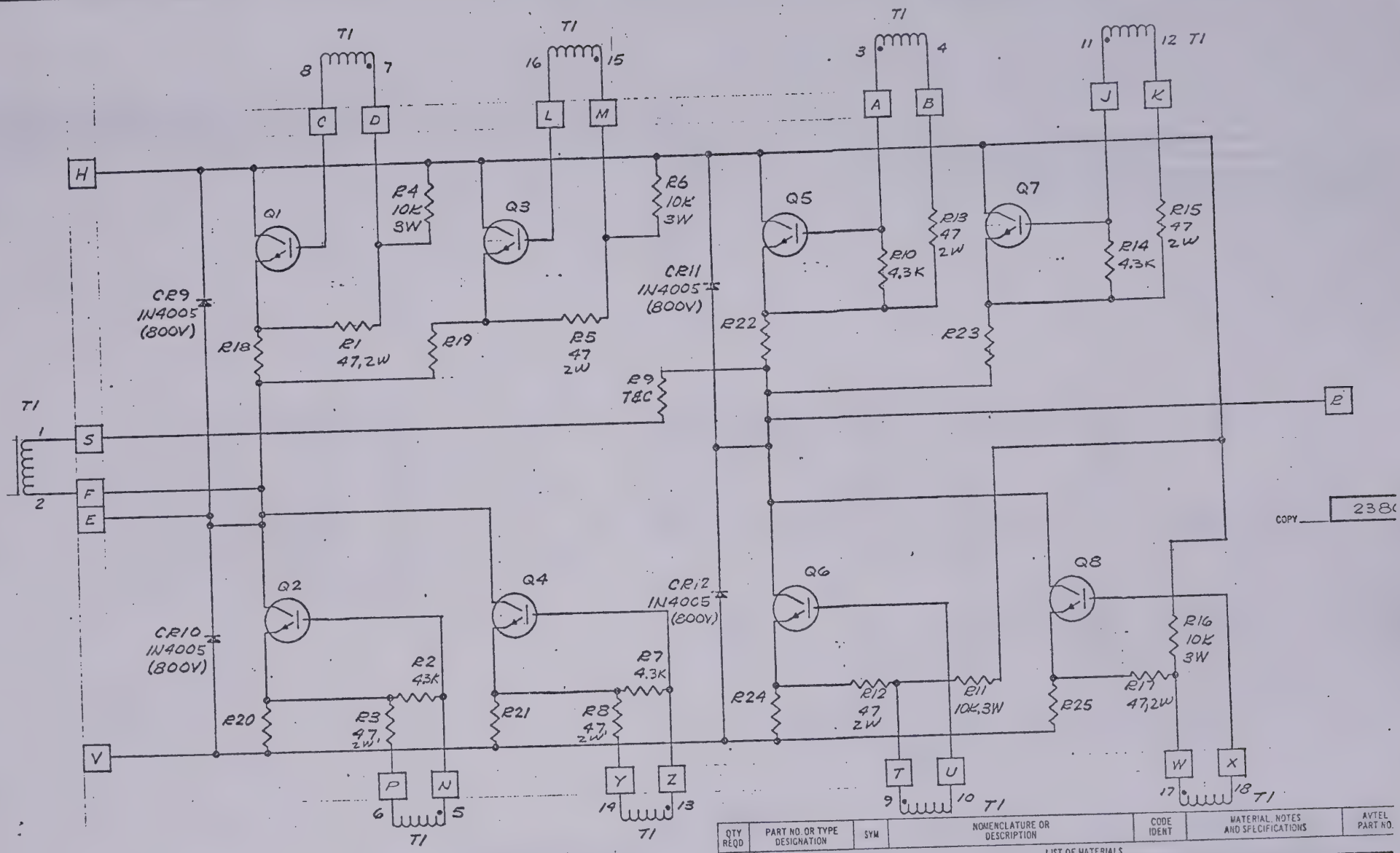
TITLE
SCHEMATIC DIAGRAM
VOLTAGE/CURRENT SENSE
PRINTED CIRCUIT BOARD

SIZE	CODE IDENT NO.	DRAWING NUMBER	REV.
C	15423	23768.	B

SCALE SHEET 1 OF 1

USED IN ANY MANNER WHATSOEVER EXCEPT BY EXPRESSED WRITTEN CONSENT OF AN AUTHORIZED EXECUTIVE OF THE AVTEL CORPORATION.

SYM			
A	PROD RELEASE PER ECO 3764		7/2/70 J.K



4. RESISTORS R18 THRU R25 ARE .1n, 1" OF #20AWG EVANOHM WIRE.
3. ALL TRANSISTORS ARE DTS-411.
1. ALL RESISTANCE IN OHMS, 1/2W, ±5%, C.C.

COPY 238

QTY REQD	PART NO. OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL, NOTES AND SPECIFICATIONS	AVTEL PART NO.

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±.060 .XX ±.030 .XXX ±.010
ANGLES X- ±1°0' X-X' ±0°30'
DIM AND TOL PER MIL STD 8
MACHINED DIA'S ON COMMON CENTER CONCENTRIC WITHIN .005 T.I.R.
125 MACHINED SURFACE ROUGHNESS PER MIL STD 10
REMOVE BURRS BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT
DO NOT MAKE CHANGES WITHOUT

23317	23016
NEXT ASSY	FINAL ASSY

MATERIAL

FINISH

CONTRACT NO.

APPD	J.W	
CHECK		
DRAWN	DBH	9-9-70
APPROVED		
APPROVED		

AVTEL CORPORATION
COVINA CALIFORNIA
A DIVISION OF AIRTRONICS, INC.

TITLE
SCHEMATIC DIAGRAM
AUXILIARY POWER INVERTER D
PRINTED CIRCUIT BOAR

SIZE	CODE IDENT NO.	DRAWING NUMBER
C	15423	23800

SCALE SHEET 1

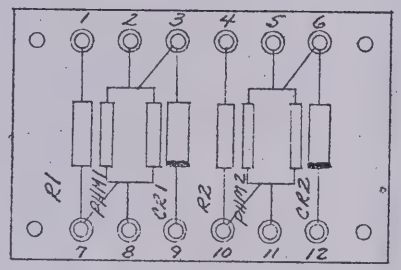
THIS DRAWING CONTAINS PROPRIETARY INFORMATION WHICH MAY NOT BE REPRODUCED OR USED IN ANY MANNER WHATSOEVER EXCEPT BY EXPRESSED WRITTEN CONSENT OF AN AUTHORIZED EXECUTIVE OF THE AVTEL CORPORATION.

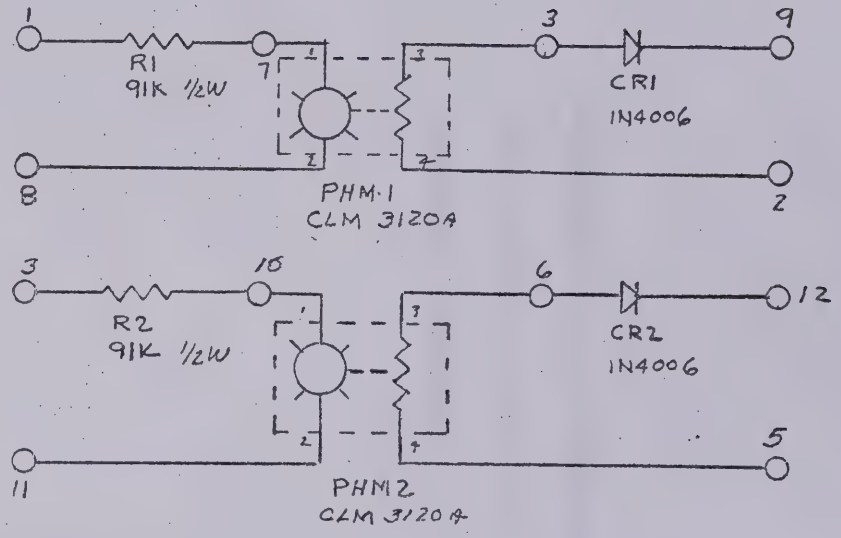
4

23795

COPY

REVISIONS				
SYM		DESCRIPTION	DATE	APPROVED
A		PROD. RELEASE PER EO 5743	11/25/70	J. W.





QTY REQD	PART NO. OR TYPE DESIGNATION	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL NOTES AND SPECIFICATIONS	AVTEL PART NO	ITEM NO

LIST OF MATERIALS

2.

1. MARK REF. DESIGNATIONS IN BLACK.

NOTES UNLESS OTHERWISE SPECIFIED.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±.060
ANGLES X° ±1°0' .XX ±.030
X°X' ±0°30' .XXX ±.010
DIM. AND TOL. PER MIL-STD-8
MACHINED DIA'S ON COMMON CENTER CONCENTRIC WITHIN .005 T.I.R.
125 MACHINED SURFACE ROUGHNESS PER MIL STD 10
REMOVE BURRS, BREAK EDGES .010 MAX
DO NOT SCALE DRAWING
REPORT ERRORS TO ENGINEERING DEPT
DO NOT MAKE CHANGES WITHOUT PROPER AUTHORIZATION

NEXT ASSY | FINAL ASSY

MATERIAL

FINISH

CONTRACT NO.

APPD	J. W.	9/9/70
CHECK		
DRAWN	GOODWIN	9/9/70

APPROVED

APPROVED

AVTEL CORPORATION
COVINA CALIFORNIA
A DIVISION OF AIRTRONICS, INC.

TITLE
ASSY-COMPONENT BOARD

SIZE	CODE IDENT NO	DRAWING NUMBER	REV
B	15423	23796	A

SCALE F.S. SHEET

ACCEPTANCE TEST PROCEDURE

FOR A MODEL CR 054-3 SU

FREQUENCY CONVERTER

AVTEL CORPORATION
1130 East Cypress Street
Covina, California 91724

0414

Document No. 29200-801

REVISIONS

LTR.	DESCRIPTION	DATE	APPROVED
A	Formal Release	8-14-74	R. Bo[illegible]

1.0 PURPOSE

This document contains a procedure to demonstrate the proper operation of a 5 KVA Frequency Converter, Avtel Model CR054-3, SU.

After the tests in this procedure are completed and the test results are approved by Avtel Quality Assurance, the Frequency Converter is considered acceptable for shipment.

2.0 FUNCTIONAL DESCRIPTION

Figure 1 shows a block diagram of the Frequency Converter. The input AC power is supplied through an input EMI filter and a circuit breaker to a DC power supply. The DC power supply rectifies the AC input voltage and provides regulated DC power to operate the inverter. The inverter is a solid state system which converts DC power from the DC power supply into regulated 400 Hz AC power.

A connector is provided at the rear of the unit to connect a cable for remote output voltage adjustment control. The output voltage can be adjusted with the VOLT ADJUST control on the front panel if the voltage adjustment switch is in the PANEL position. To adjust the voltage remotely, switch the voltage adjustment switch to REMOTE position.

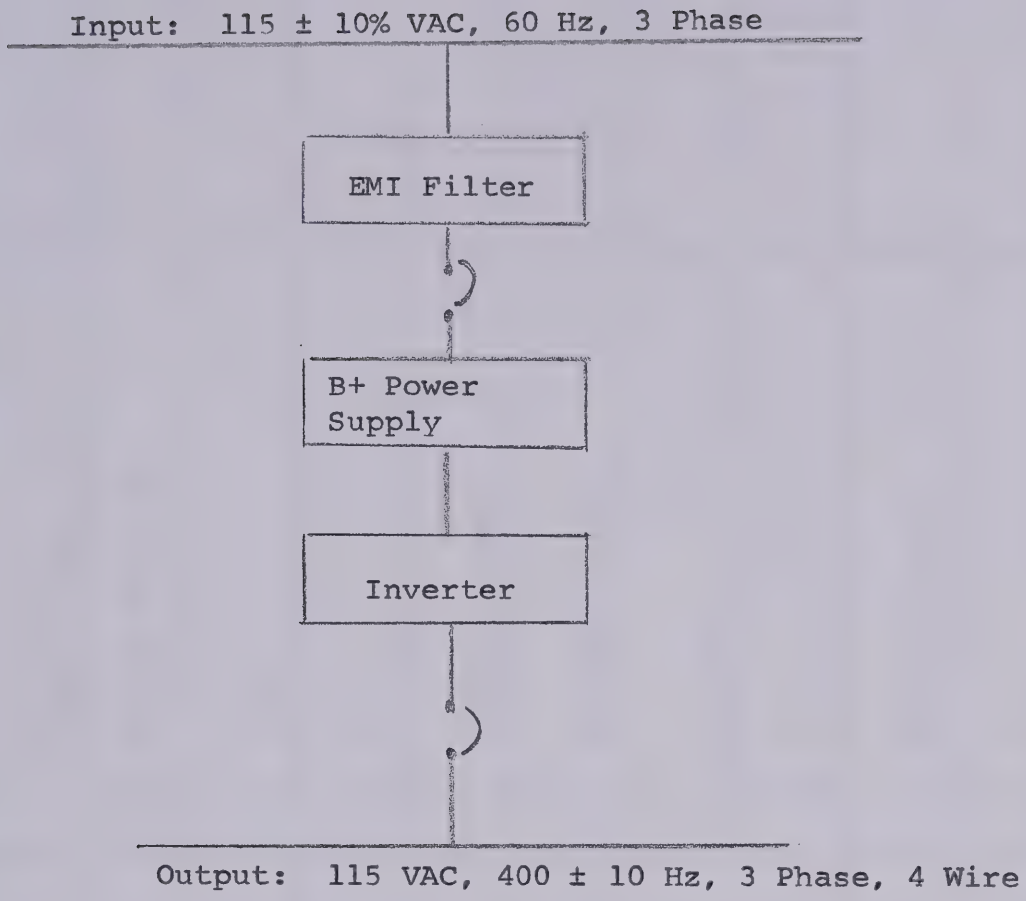


Figure 1. System Block Diagram

Part No.

Serial No.

Tested By:
Witnessed By:
Date:

Section	Parameter	Test Conditions Input VAC	Load Ø	P.F	Requirements	Test Results
1	Output Voltage Adjustment	115±1	0	-	115 ± .1 VAC	
	Freq. Adjustment	115±1	0	-	400 Hz ± 0.1 Hz	
	THD	115±1	0	-	< 1%	
2	Output Volt. Regulation	103.5±1	0	-	115 ± 3.0 VAC	
	Freq. Reg	103.5±1	0	-	400 Hz ± 2 Hz	
	THD	103.5±1	0	-	1% Max.	
3	Output Volt. Reg.	126.5±1	0	-	115 ± 3.0 VAC	

~~form E-122~~

Part No.

Serial No.

Tested By:
Witnessed By:
Date:

Section	Parameter	Test Conditions Input VAC	Load ØA	P.F	Requirements	Test Results
3(con't)	Output Freq. Reg.	126.5±1	0	-	400 ± 2 Hz	
	T.H.D.	126.5±1	0	-	1% Max.	
4	Output Volt. Reg	103.5±1	14.5±.5	1	115 ± 3.0 VAC	
	Freq Reg.	103.5±1	14.5±.5	1	400 ± 2 Hz.	
	T.H.D.	103.5±1	14.5±.5	1	1% Max.	
5	Output Volt. Reg.	115±1	14.5±.5	1	115 ± 3.0 VAC	
	Freq. Reg.	115±1	14.5±.5	1	400 ± 2 Hz.	

~~form E 122~~

Part No.

Serial No.

Tested By:
Witnessed By:
Date:

Section	Parameter	Test Conditions Input VAC	Load Ø	P.F	Requirements	Test Results
5 (con't)	Output T.H.D	115±1	14.5±.5	1	1% Max.	
6	Output Volt. Reg.	126.5±1	14.5±.5	1	115 ± 3.0 VAC	
	Freq. Regulation	126.5±1	14.5±,5	1	400 ± 2 Hz	
	T.H.D.	126.5±1	14.5±.5	1	1% max	
7	Panel Output Volt. Control Range	115±1	14.5±.5	1	102-125 VAC Min.	
	Remote Output Volt. Control Range	115±1	14.5±.5	1	102-125 VAC Min.	
10	Current Limit					
	Current Adj. Control Fully CCW	115±1		1	Current limits at 18.1A Max	

Part No.

Serial No.

Tested By:
Witnessed By:
Date:

Section	Parameter	Test Conditions Input VAC	Load Ø	P.F	Requirements	Test Results
10(cont.)	Current Adj.Control Fully CCW	115±1		1	Current limits at 8A Max	
11	Output Freq. Adj. Range	115±1	0	-	390 to 410 Hz min.	
12	Output short circuit test	115 ±1	0	-	Apply a short ØA to neutral unit shuts off	
					Remove the short, unit recycles.	

APPLICATION	
NEXT ASSY	USED ON
17509	17509

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVAL
	FORMAL RELEASE		
A	REV. PER ECOR A5944	11/8/76	
B	ADDED APPL BLK INFO	1-27-77	
C	INCORP PER ECO B 0077	4-25-77	
D	INC ECOR A6347	2-9-78	

DATE 9-27-77

SERIAL NO. 10057

PERFORMED BY

INSPECTED BY

WITNESSED BY

(2)

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE INCHES TOLERANCE FRACTIONS ± DECIMALS ± ANGLES ± REMOVE BURRS & SHARP EDGES	SIGNATURE	DATE
	DRAWN BY RES	10/14/76
	CHECKED BY	10/14/76
	PROJ	10/14/76
	APP	10/14/76
	APP	10-14-76
	CONTRACT NUMBER	

MATERIAL

FINISH

UNITRON INCORPORATED
2826 WEST KINGSLEY RD
GARLAND, TEXAS 75041
214/271-4531
TELEX 73-0644

PRODUCTION UNIT DATA SHEETS

MODEL CR054-3, P/N 17509

SIZE	CODE IDENT		
A	12175	30155	D
SCALE			SHEET 1 of 15

FORM U-500

1.0 INTRODUCTION

THIS TEST DATA SHEET IS USED IN CONJUNCTION WITH PRODUCTION UNIT TEST PROCEDURE DRAWING 30151 . PERFORM THE TESTS OUTLINED IN THE PROCEDURE AND RECORD THE DATA AS DIRECTED HEREIN. THE PARAGRAPH NUMBER OF THE TEST DATA SHEET IN WHICH THE TEST DATA IS RECORDED CORRESPONDS TO THE PARAGRAPH NUMBER OF THE TEST REQUIRED IN THE PROCEDURE.

2.0 REFERENCED DOCUMENTS

ALL DOCUMENTS NECESSARY TO SUPPORT THE TESTS ARE DEFINED UNDER PARAGRAPH 2.0 OF THE TEST PROCEDURE.

3.0 TEST EQUIPMENT REQUIRED

THE TEST EQUIPMENT NECESSARY TO MONITOR THE TEST DATA IS LISTED IN PARAGRAPH 3.0 OF THE TEST PROCEDURE.

4.0 PRODUCTION UNIT TEST PROCEDURE

REFER TO PARAGRAPH 4.0 OF PRODUCTION UNIT TEST PROCEDURE 30151 , AND PROCEED AS DIRECTED. RECORD DATA OR INITIAL AS INSTRUCTED IN THE SPACE PROVIDED HEREIN.

4.1 RESISTANCE TESTS

MEASURE RESISTANCE OF THE PRODUCTION UNIT PER PARAGRAPH 4.1.2 OF THE PROCEDURE.

CONNECTOR PIN	WITH RESPECT TO	MIN	RESISTANCE
J 101-A	CHASSIS GROUND	100K	460 KΩ
J 101-B	CHASSIS GROUND	100K	480 KΩ
J 101-C	CHASSIS GROUND	250K	310 KΩ
J 101-A	J 101-B	10	17 Ω
J 101-A	J 101-C	300K	470 KΩ
J 101-B	J 101-C	300K	470 KΩ

ALL RESISTANCE VALUES LISTED ABOVE ARE GREATER THAN THE MINIMUM VALUES LISTED IN PARAGRAPH 4.1.2 OF THE PROCEDURE.

CWR (INITIAL).

4.2 SELF PROTECTION FROM INPUT VOLTAGE VARIATION AND TRANSIENT

4.2.2 VARY THE INPUT LINE VOLTAGE BELOW AND ABOVE THE NORMAL INPUT OPERATING RANGE AND RECORD THE VOLTAGE WHICH ACTIVATES THE PROTECTION CIRCUITRY IN ACCORDANCE WITH PARAGRAPHS 4.2.2.1 THRU 4.2.2.12 OF THE TEST PROCEDURE.

4.2.2.1 UNIT WOULD NOT START WITH 249 VRMS L-L APPLIED TO THE INPUT.

CWR (INITIAL.)

4.2.2.2 UNIT WOULD NOT START WITH 166 VRMS L-L APPLIED TO THE INPUT.

CWR (INITIAL.)

4.2.2.3 STARTING AT 208 VRMS L-L INPUT, REDUCE THE INPUT VOLTAGE UNTIL THE UNIT SHUTS DOWN.

4.2.2.4

LOW LINE TRIP (NO LOAD) (171 VRMS TO 179 VRMS)	SHUT DOWN VOLTAGE
	174

4.2.2.5 UNIT OUTPUT IS NORMAL AFTER 10 SECONDS OF 187 VRMS INPUT.

CWR (INITIAL.)

4.2.2.6 INCREASE THE INPUT LINE VOLTAGE UNTIL THE UNIT SHUTS DOWN.

HIGH LINE TRIP (NO LOAD) (237 VRMS TO 244 VRMS)	SHUT DOWN VOLTAGE
	240

4.2.2.7 UNIT OUTPUT IS NORMAL AFTER 10 SECONDS OF 229 VRMS INPUT.

CWR (INITIAL.)

4.2.2.8 APPLY FULL LOAD, 0.8 P.F. LAGGING. STARTING AT 208 VOLTS RMS L-L INPUT, REDUCE THE INPUT VOLTAGE UNTIL THE UNIT SHUTS DOWN.

4.2.2.9

LOW LINE TRIP (FULL LOAD) (171 VRMS TO 179 VRMS)	SHUT DOWN VOLTAGE
	175

4.2.2.10 UNIT OUTPUT IS NORMAL AFTER 10 SECONDS OF 187 VRMS INPUT _____ (INITIAL).

4.2.2.11 INCREASE THE INPUT LINE VOLTAGE UNTIL THE UNIT SHUTS DOWN.

HIGH LINE TRIP (FULL LOAD) (237 VRMS TO 244 VRMS)	SHUT DOWN VOLTAGE
	242

4.2.2.12 UNIT OUTPUT IS NORMAL AFTER 10 SECONDS OF 229 VRMS INPUT _____ (INITIAL).

4.3 DELETED

4.3.2.2 DELETED

4.4 STARTING CURRENT AND STARTING TIME

4.4.1 REQUIREMENT - STARTING TIME

4.4.1.1 MEASURE AND RECORD THE STARTING TIME CONDITIONS DEFINED IN PARAGRAPH 4.4.2 OF THE TEST PROCEDURE.

4.4.2 TEST METHOD

4.4.2.1 PREPARE THE UNIT FOR TEST BY ADJUSTING THE INPUT AND OUTPUT

IN ACCORDANCE WITH PARAGRAPH 4.4.2.1 OF THE TEST PROCEDURE.

4.4.2.2 START UP TIME (NO LOAD): 4 SECONDS (10 SEC. MAX.)

4.4.2.3 APPLY FULL LOAD 0.8 P.F. LAGGING AND REPEAT 4.4.2.2 ABOVE.

START UP TIME (FULL LOAD): 4 SECONDS (10 SEC. MAX.)

4.4.3 REQUIREMENT - STARTING INPUT CURRENT

4.4.3.1 MEASURE THE STARTING CURRENT DEFINED IN PARAGRAPH 4.4.4 OF THE TEST PROCEDURE.

4.4.4.1 THE NO LOAD INPUT STARTING CURRENT DOES NOT EXCEED THE FULL LOAD STEADY STATE CURRENT BY MORE THAN 25% _____ (INITIAL)

4.4.4.2 THE FULL LOAD INPUT STARTING CURRENT DOES NOT EXCEED THE FULL LOAD STEADY STATE CURRENT BY MORE THAN 25% _____ (INITIAL).

4.5 GROUNDING

4.5.1 REQUIREMENT

4.5.1.1 THE UNIT SHALL OPERATE WITH A 100K RESISTOR APPLIED TO INPUTS AND OUTPUTS AS DESCRIBED IN PARAGRAPH 4.5.1.1 OF THE TEST PROCEDURE.

4.5.2 TEST METHOD

4.5.2.1 APPLY POWER AND LOADS IN ACCORDANCE WITH PARAGRAPH 4.5.2.1 OF THE TEST PROCEDURE.

4.5.2.2 THE UNIT OPERATES WITH NO OBSERVABLE DELETERIOUS EFFECTS WHEN A 100K OHM RESISTOR IS APPLIED BETWEEN CHASSIS GROUND AND:

INPUT LINE A _____ (INITIAL)

INPUT LINE B _____ (INITIAL)

INPUT LINE C _____ (INITIAL)

OUTPUT LINE A _____ (INITIAL)

OUTPUT LINE B _____ (INITIAL)

OUTPUT LINE C _____ (INITIAL)

4.6 VOLTAGE ADJUSTMENT

4.6.1 REQUIREMENT

4.6.1.1 DEMONSTRATE THAT THE OUTPUT VOLTAGE IS ADJUSTABLE OVER THE RANGE OF 108 to 132 VOLTS.

4.6.2 TEST METHOD

4.6.2.1

INPUT VOLTS: $187V_{L-L}$	MAX OUTPUT VOLTAGE OBTAINABLE
FL, 0.8 P.F. LAG.	133.6 VRMS

THE VOLTAGE RECORDED ABOVE EXCEEDS 132 VRMS

_____ (INITIAL)

INPUT VOLTS: $229V_{L-L}$	MIN OUTPUT VOLTAGE OBTAINABLE
NO LOAD	92.8 VRMS

THE VOLTAGE RECORDED ABOVE IS LESS THAN 108. VRMS

_____ (INITIAL)

4.7 OUTPUT OPERATIONAL DATA

4.7.1 OPERATE THE UNIT FROM THE VARIOUS SOURCE CONDITIONS AND UNDER THE VARIOUS LOADS SPECIFIED AS "OPERATING CONDITIONS" IN PARAGRAPHS 4.7.2.2.1 THROUGH 4.7.2.2.14 OF THE TEST PROCEDURES.

4.7.2 MEASURE AND RECORD IN THE SPACES PROVIDED BELOW THE INDICATED PARAMETERS. OUTPUT VOLTAGE BALANCE UNDER BALANCED LOAD CONDITIONS CAN BE DETERMINED BY REVIEWING THE VOLTAGE REGULATION DATA.

REFERENCE PARAGRAPH	OPERATING CONDITIONS	PARAMETER	PHASE	DATA	LIMITS
4.7.2.2.1	229V_{L-L}3Ø,60HZ No Load	Voltage (RMS)	Ø AN	120.0	117.6-122.4 (VRMS)
			Ø BN	120.1	
			Ø CN	120.2	
		Percent Distortion	Ø AN	1.4	2.0% Max.
			Ø BN	1.4	
			Ø CN	1.4	
		Amplitude Modulation	Ø AN	Less than 3.4V	OK (Initial
			Ø BN	Less than 3.4V	OK (Initial
			Ø CN	Less than 3.4V	OK (Initial
		Frequency (HZ)	Ø AN	400.3	398-402 (HZ)
4.7.2.2.2	187V_{L-L}3Ø,60HZ No Load	Voltage (RMS)	Ø AN	120.0	117.6-122.4 (VRMS)
			Ø BN	120.2	
			Ø CN	120.2	
		Frequency	Ø AN	400.3	398-402 (HZ)

SIZE	CODE IDENT NO.	DRAWING NO.
A	12175	30155
SCALE		SHEET 7 OF 15

12 7/7:

REFERENCE PARAGRAPH	OPERATING CONDITIONS	PARAMETER	PHASE	DATA	LIMITS
4.7.2.2.3	187V_{L-L}3Ø,60HZ HL, 0.7 P.F., Leading	Voltage (RMS)	Ø AN	120.4	117.6-122.4 (VRMS)
			Ø BN	120.6	
			Ø CN	120.5	
4.7.2.2.4	229V_{L-L}3Ø,60HZ HL, 0.7 P.F., Leading	Voltage (RMS)	Ø AN	120.4	117.6-122.4 (VRMS)
			Ø BN	120.6	
			Ø CN	120.5	
4.7.2.2.5	229V_{L-L}3Ø,60HZ FL, 0.7 P.F., Leading	Voltage (RMS)	Ø AN	120.6	117.6-122.4 (VRMS)
			Ø BN	120.8	
			Ø CN	120.7	
		Percent Distortion	Ø AN	1.0	2.0% Max.
			Ø BN	1.0	
			Ø CN	1.0	
		Amplitude Modulation	Ø AN	< 3.4V	(Initial)
			Ø BN	< 3.4V	(Initial)
			Ø CN	< 3.4V	(Initial)
		Frequency (HZ)	Ø AN	401.3	398-402 (HZ)
4.7.2.2.6	187V_{L-L}3Ø,60HZ FL, 0.7 P.F., Leading	Voltage (RMS)	Ø AN	120.7	117.6-122.4 (VRMS)
			Ø BN	120.8	
			Ø CN	120.7	
4.7.2.2.7	187V_{L-L}3Ø,60HZ HL, Unity P.F.		Ø AN	119.7	117.6-122.4 (VRMS)
			Ø BN	120.0	
			Ø CN	120.0	

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REFERENCE PARAGRAPH	OPERATING CONDITIONS	PARAMETER	PHASE	DATA	LIMITS
4.7.2.2.8	229V_{L-L}3Ø,60HZ HL, Unity P.F.	Voltage (RMS)	Ø AN	119.9	117.6-122.4 (VRMS)
			Ø BN	120.0	
			Ø CN	120.0	
4.7.2.2.9	229V_{L-L}3Ø,60HZ FL, Unity P.F.	Voltage (RMS)	Ø AN	119.7	117.6-122.4 (VRMS)
			Ø BN	119.8	
			Ø CN	119.8	
		Percent Distortion	Ø AN	1.1	2.0% Max.
			Ø BN	1.1	
			Ø CN	1.1	
		Amplitude Modulation	Ø AN	< 3.4V	(Initial)
			Ø BN	< 3.4V	(Initial)
			Ø CN	< 3.4V	(Initial)
		FrequencyHZ	Ø AN	400.3	398-402 (HZ)
4.7.2.2.10	187V_{L-L}3Ø,60HZ FL, Unity P.F.	Voltage (RMS)	Ø AN	119.7	117.6-122.4 (VRMS)
			Ø BN	119.8	
			Ø CN	119.8	
4.7.2.2.11	187V_{L-L}3Ø,60HZ HL, 0.7 P.F. Lagging	Voltage (RMS)	Ø AN	119.5	117.6-122.4 (VRMS)
			Ø BN	119.6	
			Ø CN	119.7	
4.7.2.2.12	229V_{L-L}3Ø,60HZ HL, 0.7 P.F. Lagging	Voltage (RMS)	Ø AN	119.5	117.6-122.4 (VRMS)
			Ø BN	119.6	
			Ø CN	119.7	

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REFERENCE PARAGRAPH	OPERATING CONDITIONS	PARAMETER	PHASE	DATA	LIMITS
4.7.2.2.13	229V_{L-L}3Ø,60HZ FL, 0.7 P.F. Lagging	Voltage (RMS)	Ø AN	119.0	117.6-122.4 (VRMS)
			Ø BN	119.2	
			Ø CN	119.4	
		Percent Distortion	Ø AN	1.7	2.0% Max.
			Ø BN	1.1	
			Ø CN	1.7	
		Amplitude Modulation	Ø AN	< 3.4V	(Initial)
			Ø BN	< 3.4V	(Initial)
			Ø CN	< 3.4V	(Initial)
		Frequency (HZ)	Ø AN	400.3	398-402 (HZ)
4.7.2.2.14	187V_{L-L}3Ø,60HZ FL, 0.7 P.F. Lagging	Voltage (RMS)	Ø AN	119.1	117.6-122.4 (VRMS)
			Ø BN	119.2	
			Ø CN	119.2	

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4.8 OUTPUT VOLTAGE BALANCE UNDER UNBALANCED LOAD CONDITIONS

4.8.1 REQUIREMENT

THE UNIT SHALL MAINTAIN BALANCED PHASE OUTPUT WITHIN THE LIMITS DESCRIBED IN PARAGRAPH 4.8.1 OF THE TEST PROCEDURE.

4.8.2 TEST METHOD

APPLY A LOAD UNBALANCE IN ACCORDANCE WITH PARAGRAPH 4.8.2 OF THE TEST PROCEDURE.

4.8.2.1

ØAN 118.4 VOLTS RMS		
ØBN 119.5 VOLTS RMS	ØAN LOADED	
ØCN 120.6 VOLTS RMS		

THE VOLTAGE DIFFERENCE BETWEEN PHASES IS NO GREATER THAN ± 6 VOLTS CMR (INITIAL)

4.8.2.2

ØAN 120.0 VOLTS RMS		
ØBN 119.0 VOLTS RMS	ØBN LOADED	
ØCN 120.0 VOLTS RMS		

THE VOLTAGE DIFFERENCE BETWEEN PHASES IS NO GREATER THAN ± 6 VOLTS CMR (INITIAL)

4.8.2.3

ØAN 120.0 VOLTS RMS		
ØBN 120.1 VOLTS RMS	ØCN LOADED	
ØCN 119.0 VOLTS RMS		

THE VOLTAGE DIFFERENCE BETWEEN PHASES IS NO GREATER THAN ± 6 VOLTS _____ (INITIAL)

4.9 OVERLOAD

4.9.1 REQUIREMENT

DEMONSTRATE THE UNIT'S PERFORMANCE WHEN SUBJECTED TO A 125% OVERLOAD. RECORD THE RESULTS.

4.9.2.1 APPLY THE 125% LOAD IN ACCORDANCE WITH PARAGRAPH 4.9.2.1 OF THE TEST PROCEDURE FOR A ONE MINUTE MINIMUM DURATION.

Ø AN 119.6 (117.6 V MIN, 122.4 V MAX)

Ø BN 119.7 (117.6 V MIN, 122.4 V MAX)

Ø CN 119.6 (117.6 V MIN, 122.4 V MAX)

THE VOLTAGE AT EACH PHASE REMAINED WITHIN LIMITS FOR A PERIOD GREATER THAN ONE MINUTE _____ (INITIAL)

4.10 SHORT CIRCUIT AND FAULT CURRENT

4.10.1 REQUIREMENT

4.10.1.1 DETERMINE THE UNIT'S PERFORMANCE WHEN SUBJECTED TO SHORT CIRCUIT AND/OR OVERLOAD CONDITIONS AS DESCRIBED IN PARAGRAPH 4.10.1.1 OF THE TEST PROCEDURE.

4.10.2 TEST METHOD

4.10.2.1 OPERATE THE UNIT FROM A VARIAC ADJUSTED TO 229 VOLTS, 3Ø, 60 HZ WHILE HAVING FULL RATED LOAD, UNITY P.F. APPLIED.

4.10.2.2 THE OUTPUT CURRENT LEVEL REMAINED AT A 150% LEVEL FOR A MINIMUM OF 10 SECONDS WHEN THE UNIT WAS SUBJECTED TO 150% LOAD.

_____ (INITIAL)

4.10.2.3 THE OVERLOAD CURRENT INDICATOR TRIP POINT IS 152 % LOAD CURRENT. (150% MIN., 160% MAX)

4.10.2.4 AT FULL OUTPUT AND FULL RATED LOAD, UNITY P.F., THE UNIT SHUT DOWN PROPERLY EITHER BY CIRCUIT BREAKER OPERATION OR BY ELECTRONIC SENSING, WHEN SUBJECTED TO A SINGLE PHASE MOMENTARY SHORT.

CMR (INITIAL)

4.10.2.5 UNDER THE CONDITIONS OF 4.10.2.4, THE UNIT SHUT DOWN PROPERLY WHEN SUBJECTED TO A MOMENTARY SHORT APPLIED SIMULTANEOUSLY TO ALL THREE PHASES.

CMR (INITIAL)

4.10.2.6 REDUCE THE INPUT LINE TO 187 VOLTS 3Ø.

4.10.2.7 REPEAT 4.10.2.2. THE OUTPUT CURRENT REMAINED AT A 150% LEVEL FOR A MINIMUM OF 10 SECONDS.

CMR (INITIAL)

4.10.2.8 REPEAT 4.10.2.3. THE OVERLOAD CURRENT INDICATOR TRIP POINT IS 154 % LOAD CURRENT. (150% MIN, 160% MAX)

4.10.2.9 UNDER THE CONDITONS OF 4.10.2.4, THE UNIT SHUT DOWN PROPERLY.

CMR (INITIAL)

4.10.2.10 UNDER THE CONDITIONS OF 4.10.2.5, THE UNIT SHUT DOWN PROPERLY.

CMR (INITIAL)

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4.11 DELETED

4.11.1 DELETED

4.11.2 DELETED

4.11.2.1 DELETED

4.11.2.2 DELETED

4.12 TRANSIENT VOLTAGE AND RECOVERY

4.12.1 REQUIREMENT

DETERMINE THAT THE UNIT RESPONDS TO LOAD CHANGES AS DESCRIBED IN PARAGRAPH 4.12.1 OF THE TEST PROCEDURE.

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4.12.2 TEST METHOD

APPLY POWER AND LOADS IN ACCORDANCE WITH PARAGRAPH 4.12.2.1.

Reference Paragraph Number	* Load Change From	To	Instantaneous Ø AN Voltage (Limits: 147-192 V_{pk})	Regulated Ø AN Voltage (Limits within 0.1 Sec.: 166-174 V_{pk})
4.12.2.1	NL	50%	154 V_{pk}	172 V_{pk}
4.12.2.2	50%	FL	154 V_{pk}	172 V_{pk}
4.12.2.3	FL	50%	160 V_{pk}	172 V_{pk}
4.12.2.4	75%	25%	160 V_{pk}	172 V_{pk}

* All Loads are 0.8. P.F. Lagging

4.13 RUN IN

4.13.1 REQUIREMENT

4.13.1.1 SUBJECT THE UNIT TO THE LINE AND LOAD CONDITIONS SPECIFIED IN PARAGRAPH 4.13.1.1 OF THE TEST PROCEDURE FOR FOUR HOURS

4.13.2 TEST METHOD

4.13.2.1 OPERATE THE UNIT FROM AN INPUT LINE VOLTAGE OF 208 VOLTS, 3Ø, 60 HZ. APPLY FULL RATED LOAD 0.8. P.F. LAGGING.

4.13.2.2 AFTER FOUR HOURS ALL THREE PHASE OUTPUT VOLTAGES ARE WITHIN THE SPECIFIED LIMITS OF 117.6-122.4 VOLTS RMS.

_____ (INITIAL)

Reference Paragraph Number	* Load Change From To	Instantaneous P-N Voltage (Limits: 147-190V V_{pk})	Depleted P-N Voltage (Limits within 0.1 Sec.: 156-174V V_{pk})
4.12.2.3	OL 50%	_____ V_{pk}	_____ V_{pk}
4.12.2.4	50% OL	_____ V_{pk}	_____ V_{pk}
4.12.2.5	OL 50%	_____ V_{pk}	_____ V_{pk}
4.12.2.6	75% 25%	_____ V_{pk}	_____ V_{pk}

* All loads are 0.8 P.F. lagging